Mead's Milkweed (*Asclepias meadii* Torr.)
Draft Recovery Plan

U.S. Department of the Interior
United States Fish and Wildlife Service
Great Lakes - Big Rivers Region (Region 3)
Fort Snelling, Minnesota

MEAD'S MILKWEED
(*Asclepias meadii* Torr.)

DRAFT RECOVERY PLAN

Prepared by

Marlin Bowles
and

The Mead's Milkweed Recovery Team

for

Region 3
U. S. Fish and Wildlife Service
Fort Snelling, MN

Approved: XXXXXXXXXXXXXXXXXX
Regional Director, Region 3
U. S. Fish and Wildlife Service

Date: ________________________

DISCLAIMER

Recovery plans delineate reasonable actions needed to recover and/or protect listed species. Plans are published by the U. S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. The purpose of the plan is to promote the conservation of the threatened Mead's milkweed (*Asclepias meadii*) by implementing identified tasks. Recovery objectives will be attained and funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

This plan does not necessarily represent the views or official position of any individuals or agencies involved in plan formulation, other than the U. S. Fish and Wildlife Service. They represent the views of the U. S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citation:

U. S. Fish and Wildlife Service. 2002. Technical/Agency Draft Mead's milkweed (*Asclepias meadii*) Recovery Plan. Fort Snelling, Minnesota. 104 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814

Telephone: 1-800-582-3421 or 301- 492-6403; Website: http://fa.r9.fws.gov/r9fwrs/

TTY users may contact the Fish and Wildlife Reference Service through the Federal Relay Service at 1-800-877-8339.

The fee varies depending on the number of pages of the Plan.

EXECUTIVE SUMMARY
Mead's Milkweed Recovery Plan

Current Status: The federally threatened Mead's milkweed (*Asclepias meadii*) is currently known to persist at 171 sites in 34 counties in eastern Kansas, Missouri, south-central Iowa, and southern Illinois. Populations no longer occur in Wisconsin and Indiana. Seventy-five percent of the Mead's milkweed populations are in the Osage Plains Physiographic Region in Kansas and Missouri. The remainder of the populations occur in the Shawnee Hills of Illinois; the Southern Iowa Drift Plain in Iowa; the Glaciated Plains, Ozark Border, Ozark Springfield Plataea, and the Ozark-St. Francois Mountains of Missouri; and the Glaciated Physiographic Region of Kansas. Mead's milkweed populations have been eliminated by wide-scale agriculture in the eastern part of the species' range. Many large populations occur in private hay meadows where a century of annual mowing has severely reduced genetic diversity by preventing sexual reproduction. Among the surviving populations in eastern Missouri, Illinois, and Iowa, most apparently consist of a few genetically invariant clones that are incapable of reproduction. Population restoration efforts are being made in Illinois, Indiana, and Wisconsin by introducing Mead's milkweed into suitable habitat.

Habitat Requirements and Limiting Factors: Mead's milkweed occurs primarily in tallgrass prairie and occasionally in thin-soil glades or barrens. This plant is essentially restricted to late-successional prairie habitat that has never been plowed and only lightly grazed and hay meadows that are cropped annually for hay. Plants reproduce sexually producing seeds, and vegetatively by rhizomes, especially under midsummer hay mowing regimes. As with other native milkweeds, Mead's is either self-incompatible or subject to severe inbreeding depression. Mead's milkweed populations that are managed by prescribed burning show an increase in flowering, reproduction, and seedling establishment and are more genetically diverse than sites that are mowed.

Recovery Objective: Delisting.

Recovery Criteria:

1. Twenty-six populations are distributed across plant communities and physiographic regions within the historic range of the species (See Table 7 for distribution of these populations).

2. Each of these 26 populations is highly viable. A highly viable population is defined as follows: more than 50 mature plants; seed production is occurring and the population is increasing in size and maturity; the population is genetically diverse with more than 50 genotypes; the available habitat size is at least 125 acres (50 hectares) in size; the habitat is in a late-successional stage; the site is protected through long-term conservation easements, legal dedication as nature preserves, or other means; and the site is managed by fire in order to maintain a late successional graminoid vegetation structure that is free of woody vegetation (Bowles and Bell 1998).

3. Monitoring data indicates that these populations have been stable or increasing for 15 years.

<u>Actions Needed</u>:
1. Protect habitat
2. Manage habitat
3. Increase size and number of populations
4. Conduct field surveys for new population occurrences or potential habitat for introduction
5. Conduct research on restoration, management, and introduction techniques
6. Maintain conservation populations.
7. Promote public understanding.
8. Review and track recovery progress

<u>Estimated Cost of Recovery</u>: $5,905,000.

<u>Date of Recovery</u>: Recovery could occur by 2033, if recovery criteria are met.

Mead's Milkweed Recovery Team Members

The U. S. Fish and Wildlife Service wishes to acknowledge the following individuals for their efforts on behalf of the species and their assistance with this plan:

Steve Chaplin, *Leader*
The Nature Conservancy
Midwest Regional Office
1313 5th Street S.E., Suite 314
Minneapolis, Minnesota 55414

Robert Betz
Northeastern Illinois University
Department of Biology
5500 N. St. Louis
Chicago, Illinois 60625

Craig Freeman
Kansas Natural Heritage Inventory
Kansas Biological Survey
2041 Constant Ave.
Lawrence, Kansas 66047-2906

Dean Roosa
Iowa Department of Natural Resources
Wallace State Office Building
Des Moines, Iowa 50319

Tom Toney
Missouri Department of Conservation
RR 3, Box 47
Lockwood, Missouri 65682

ACKNOWLEDGMENTS

The U. S. Fish and Wildlife Service gratefully acknowledges the work of the many individuals who contributed to the preparation of this document. Marlin Bowles, of the Morton Arboretum in Lisle, Illinois, is the primary author of the plan. Many others have provided information and expertise, including John Pearson, Iowa Department of Natural Resources; William Watson, Iowa Field Office, The Nature Conservancy and University of Northern Iowa; Peggy Horner and Tim Smith, Missouri Department of Conservation; Jennifer Delisle, Kansas Biological Survey, Rich Anderson, Wisconsin Bureau of Endangered Resources; and Amy Salveter, U. S. Fish and Wildlife Service - Columbia, Missouri Field Office.

In addition, other U. S. Fish and Wildlife Service Staff at the following field offices also assisted in recovery plan development: Columbia, Missouri; Rock Island, Illinois; Manhattan, Kansas; and Chicago, Illinois.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PART I: INTRODUCTION

Mead's milkweed (*Asclepias meadii* Torrey) is a long-lived "tallgrass" prairie perennial herb belonging to the milkweed family (Asclepiadacea). The genus *Asclepias* includes approximately 150 species (Cronquist 1981), most of which occur in North America. The genus has a long history of study because of its myriad uses (Gaertner 1979) and highly specialized flowers (Bookman 1981; Wyatt and Shannon 1986). Mead's milkweed was first discovered in 1843 in Hancock County, Illinois by Dr. Samuel Barnum Mead, a pioneer medical doctor (Jones 1952; Betz 1967; Mohlenbrock 1983; Betz 1989) and was eventually found in five other states by 1900 (Mohlenbrock 1983). Mead (1846) originally identified the plant as *Asclepias cordata*, but it was later described as a separate species by Torrey as *Asclepias meadii* (Gray 1856).

As a result of fragmentation and destruction of the tallgrass prairie, Mead's milkweed populations have declined in Kansas, Missouri, Iowa, and Illinois. The species has been extirpated from Wisconsin and Indiana. The U. S. Fish and Wildlife Service (Service) listed the Mead's milkweed as a threatened species on September 1, 1988, under the Endangered Species Act (Act)of 1973 as amended (USFWS 1988). This document is designed to guide the recovery of the species throughout its historic range.

SPECIES DESCRIPTION

Mead's milkweed has been observed in Kansas and Missouri prairies with up to 11 native species of other milkweeds, including sand milkweed (*Asclepias amplexicaulis* Sm.), tall green milkweed (*A. hirtella* (Penn.) Woods), swamp milkweed (*A. incarnata* L.), showy milkweed (*A. speciosa* Torr.), narrow leaved milkweed (*A. stenophylla* A. Gray), prairie milkweed (*A. sullivantii* Engelm.), common milkweed (*A. syriaca* L.), butterfly milkweed (*A. tuberosa* L.), whorled milkweed (*A. verticillata* L.), short green milkweed (*A. viridiflora* Raf.), and spider milkweed (*A. viridis* Raf.). Mead's milkweed is readily distinguished from these and other species by a combination of smooth stalkless opposite leaves with a herringbone venation and a single nodding umbel (a type of flower cluster) consisting of large fragrant greenish-cream flowers (Figure 1). Immature plants may resemble those of other milkweeds or species in the related dogbane (Apocynaceae) family. Juvenile or seedling plants are often difficult to locate and identify due to their small stature and slender linear leaves.

Mead's milkweed usually begins its seasonal growth in mid to late April. It has a single slender unbranched stalk, 8-16 inches (20-40 centimeters) high without hairs but with a whitish waxy covering. The hairless leaves are opposite, broadly ovate, 2-3 inches (5-7.5 centimeters) long, 3/8-2 inches (1-5 centimeters) wide, with a whitish waxy covering. A solitary umbel at the top of the stalk has 6-15 greenish ivory/cream colored flowers, which appear in late May and early June. Young green fruit pods appear by late June and reach their maximum length of 1.5-3 inches (4-8 centimeters) by late August or early September. As these pods mature, they darken, and the hairy seeds borne within are mature by mid-October (Morgan 1980; Kurz and Bowles 1981; USFWS 1988).

Figure 1. Illustration of fruiting and flowering stems of Mead's milkweed.

DISTRIBUTION AND STATUS

Mead’s milkweed formerly occurred throughout the eastern tallgrass prairie region of the central United States extending from Kansas (Carruth 1877; Gates 1940; McGregor 1948) through Missouri (Tracy 1888; Woodson 1954; Steyermark 1977), and Illinois (Mead 1846; Lapham 1857; Patterson 1876; Brendel 1887; Huett 1897; McDonald 1899; Jones 1952) to southern Iowa (Fitzpatrick and Fitzpatrick 1899; Greene 1907), southwest Wisconsin (Greene 1880, 1898), and northwest Indiana (Deam 1940). Historically, Mead's milkweed is known from a total of 46 counties in Illinois (Kurz and Bowles 1981), Indiana (Betz 1988; LeBlanc 1988), Iowa (Watson 1983), Kansas (Freeman 1988), Missouri (Morgan 1980), and Wisconsin (Alverson 1981) (Figure 2).

Based on historical collections Mead’s milkweed has been extirpated from Wisconsin and Indiana. Counties in Illinois where Mead’s milkweed has been extirpated include Cook, Ford, Fulton, Hancock, Henderson, LaSalle, Menard, and Peoria counties (Phillippe *et al.* 2000; Bowles *et al*. 2001a). Historical collections in Iowa were made in Adams, Clinton, Decatur, Scott, and Warren counties (Watson 1983); however, Decatur County is the only one with an extant population (Watson 1992). In Missouri, historical records are from Henry, Johnson, Pettis, St. Louis, and Scotland counties. There are unverified records for Jackson and Putnam counties in Missouri, but extant populations no longer exist in any of these counties. Currently, Missouri populations occur in Barton, Benton, Cass, Cedar, Harrison, Henry, Iron, Pettis, Polk, Reynolds, St. Clair, and Vernon counties. In Kansas, the species is not known to be extirpated from any counties although two of the six historical populations are confirmed destroyed. The vast majority of Kansas populations were discovered after 1950 although there is at least one known pre-1900 collection (Freeman 1988). A report from Harvey County, Kansas, is not supported by a specimen and probably is inaccurate.

Mead's milkweed currently is known from 171 sites in 34 counties in eastern Kansas, Missouri, south-central Iowa, and southern Illinois (Figure 2, Appendix 2). All extant populations lie within a rectangle delimited by the coordinates: 37ENorth latitude (South), 42ENorth latitude (North), 88EWest longitude (East), and 96EWest longitude (West). The majority of counties with extant populations are clustered within a 125 square mile area of eastern Kansas (Jennifer Delisle, Kansas Biological Survey, pers. comm. 2002) and southwest Missouri (T. Smith, Missouri Department of Conservation, pers. comm. 2002). Outside this area, populations are widely dispersed across 11 counties of northern Missouri, southeast Missouri, southwest Iowa and southern Illinois.

Only a few viable Mead's milkweed populations exist based on State heritage program rankings, which integrate population size and habitat integrity (Table 1). Appendix 3 provides an explanation of the specifications used to rank Mead’s milkweed populations. Only seven (4.2%) of the 171 extant milkweed populations are ranked as "A,” and only nine (5.4%) are "B" ranked. Most Mead's milkweed populations are small, with 75 percent of the populations having less than 25 ramets. Five of the "A" ranked populations and eight of the "B" ranked populations are in Kansas. All but two of these are private hay meadows that are annually mowed in midsummer, removing flowering heads and forcing populations to persist vegetatively. One exception, the "A" ranked Rockefeller Prairie, is owned by Kansas University, Lawrence, and

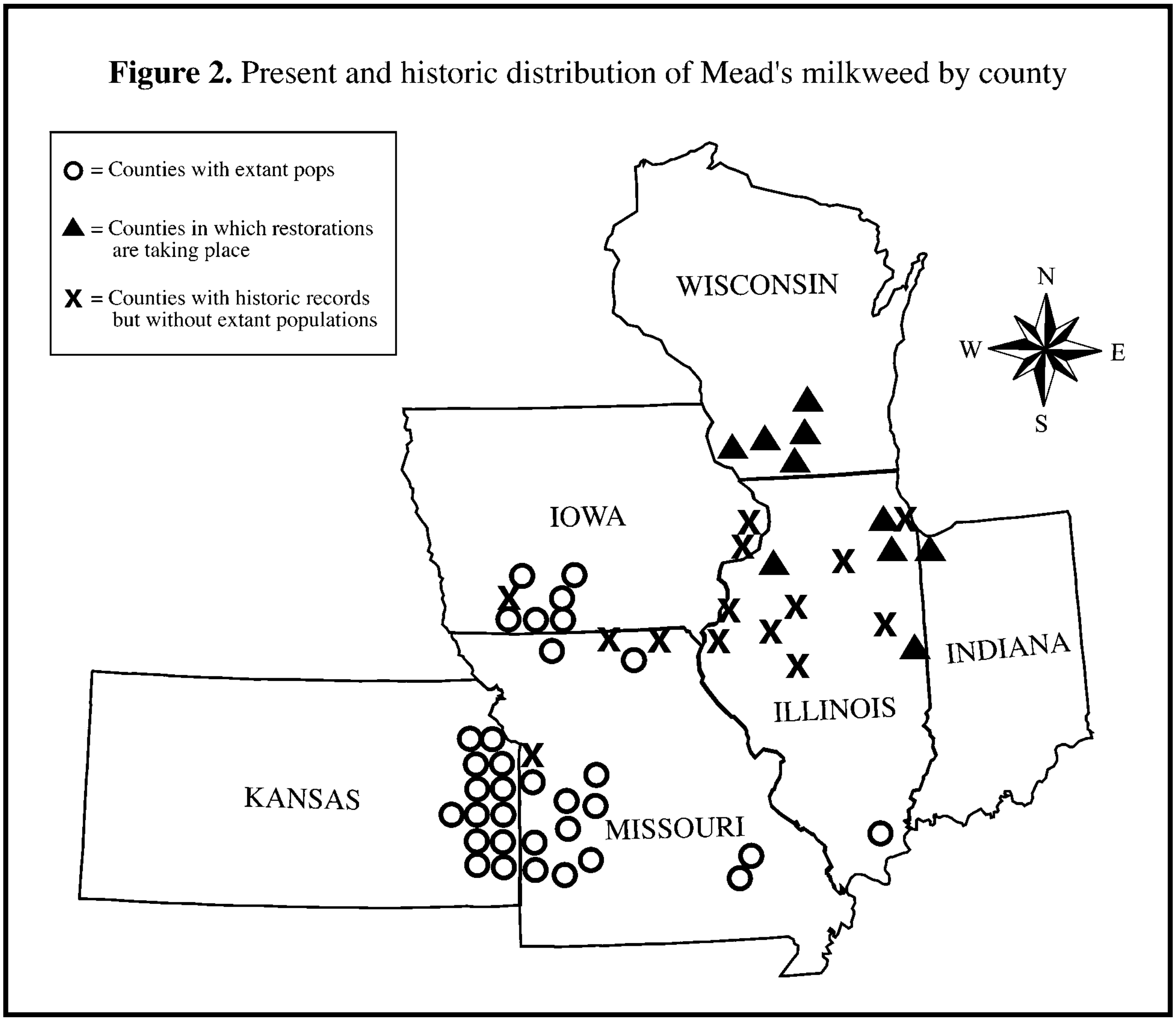

FIGURE 2. Present and historic distribution of Mead's milkweed by county.

Table 1. Natural Heritage ranking and number of extant natural Mead's milkweed populations by physiographic region and State. Ranking is based on population size and habitat integrity. A = >200 ramets, B = >100 ramets, C = >25 ramets, D = <25 ramets, E = no data. An explanation of the element global ranking specifications for Mead's milkweed can be found in Appendix 3.

PHYSIOGRAPHIC REGION	STATE	Number and rank of populations						Total
		A	B	C	D	E	?	
Unglaciated								
Osage plains (sandstone/chert)	Kansas	4	7	22	43	5	12	93
Osage plains (sandstone/chert)	Missouri	0	0	23	13	0	0	36
Ozark Border (chert)	Missouri	0	0	0	3	0	0	3
Ozark-Springfield Plateau (limestone)	Missouri	1	0	3	6	0	0	10
Ozark-St. Francois Mts.(igneous)	Missouri	1	1	4	1	0	0	7
Shawnee Hills (limestone)	Illinois	0	0	0	4	0	0	4
Driftless (dolomite)	Wisconsin	0	0	0	0	0	0	0
Glaciated (glacial stage)								
Glaciated Region (Kansan)	Kansas	1	1	0	4	2	0	8
Southern Iowa Drift Plain (Kansan)	Iowa	0	0	1	6	0	0	7
Glaciated Plains (Kansan)	Missouri	0	0	1	2	0	0	3
Western Forest-prairie (Illinoisan)	Illinois	0	0	0	0	0	0	0
Grand Prairie (Wisconsonian)	Illinois	0	0	0	0	0	0	0
Grand Prairie (Wisconsonian)	Indiana	0	0	0	0	0	0	0
TOTAL		7	9	54	82	7	12	171

has been fire-managed since 1956. This 4.5 hectare (11.25-acre) prairie has more than 200 ramets where 15% of flowering stems produce seed pods annually (Kettle *et al.* 2000). Missouri has two "A" ranked populations, the Niawathe public prairie, a former hay meadow, and the Ketcherside Mountain Conservation Area, and one "B" ranked population, Taum Sauk Mountain State Park. Among the 11 sites in Illinois and Iowa there is only one “C” ranked population, the remaining are "D" ranked. Each of these “D” ranked populations consist of only one or two clones that persist vegetatively and do not produce seeds (Watson 1983, 1992, 1998, 1999, 2000, 2001; Bowles *et al.* 2001a).

Kansas

The 101 Kansas occurrences are distributed among 13 counties (Appendix 2), with most in Anderson, Douglas, and Franklin counties (Jennifer Delisle, pers. comm. 2002). Kansas populations are found in eastern counties of the State and range from approximately 15 miles north of the Kansas River south to northern Neosho County, and from the Missouri border west to the central Osage Cuestas. Mead’s milkweed can be found growing in the unglaciated material of the Osage Plaines Physiographic Region and in glaciated material of the Kansan Glaciated Physiographic Region. Almost all Mead’s milkweed sites in Kansas are currently being used as hay meadows with the exception of a few sites that are managed by different rotations.

Missouri

In Missouri, the majority of Mead’s milkweed populations are on public land that is protected and managed (Horner 2001). All but 10 of the 59 extant Missouri populations occur in eight southwest-central Missouri counties, with nearly half of the occurrences in Benton and Pettis counties (T. Smith, pers. comm. 2002). Seven populations have been discovered on igneous glade habitat in Missouri's Ozark Physiographic Region, with five sites in Iron County and two in Reynolds County. An 1898 collection site at Buzzard Mountain, Iron County, has apparently been relocated but Mead's milkweed was not found. In 2001, a new population was found in Adair County, northern Missouri, from which Mead’s milkweed was believed to be extirpated. Although new populations have recently been found, the long-term viability of many Missouri populations is unknown, with most sites lacking sexual reproduction (Horner 2001).

Illinois

Illinois' four extant populations are in Saline County on United States Forest Service land (Sheviak 1981; Schwegman 1987; Tecic *et al.* 1998; Bowles 2001a; Hayworth *et al.* 2001). All of these remaining populations are in the Shawnee Hills Physiographic Region in unglaciated southern Illinois (Schwegman *et al.* 1973). These occurrences are located within 2 miles of each other along a sandstone escarpment (J. Schwegman, Illinois Department of Natural Resources, pers. comm. 1988). The populations in Saline County are remnants of a once larger population that has been fragmented by fire protection. The last remaining population of Mead’s milkweed occurring in tallgrass prairie habitat of Illinois was destroyed in 2001 after a change of ownership of an informally protected site in Ford County (Bowles *et al.* 2001a).

Iowa

Seven Mead’s milkweed populations occur in six Iowa counties including Adair, Clarke, Decatur, Ringgold, Taylor, and Warren Counties (Watson 1983, 1992, 1998, 1999, 2000, 2001). These populations are in the southern half of the State in the west-central portion of the Southern

Iowa Drift Plain (Prior 1976). Most of the sites have not been observed in recent years and may already be extirpated. Woodside Prairie and Powell Prairie are the only sites where Mead’s can be consistently found and accessed (Watson 2001).

Distribution and Status by Physiographic Region
The main goal in recovery of the Mead’s milkweed is to preserve or restore viable populations within each physiographic region of each State formerly occupied by this species. Therefore, understanding the current distribution of Mead’s milkweed across states and physiographic regions is important in order to comprehend what will be required to delist the species. This section of the plan and Appendix 4 provide this current distribution and status information.

Unglaciated Osage Plains (Kansas) Seventy-five percent of the Mead's milkweed populations occur in the Osage Plains Physiographic Region, and the majority of those occur in Kansas. Although the Osage Plains Region occurs across Kansas and Missouri, the portion that occurs in each State is ecologically different, with higher pH levels and nutrient concentrations in Kansas than in Missouri.

Unglaciated Osage Plains (Missouri) This region includes the extension of the Osage Plains into Missouri, which supports most Missouri populations. These sites occur on chert soils and appear to be more acid and nutrient poor than soils in Kansas. All of the extant populations occur in hay meadows or public prairie restorations that were once hay meadows.

Unglaciated Ozark St. Francois Mountains (Missouri) Habitats in this region are found in igneous glades with acidic nutrient-poor soils. Seven populations have been found in this region. One population, Ketcherside Mountain Conservation Area, is “A” ranked and occurs in natural habitat.

Unglaciated Shawnee Hills (Illinois) The four extant populations of Mead’s milkweed in Illinois occur only in this region in open barren remnants over sandstone bedrock in the Shawnee National Forest. All of these populations have an element occurrence rank of “D,” and each consists of a single genetically identical clone. Efforts should be made to increase the amount of genetic diversity in these populations by introducing other plants.

Unglaciated driftless (Wisconsin) Only a single historic collection was made of Mead's milkweed in this region, and it has not been relocated. In 2001, the Wisconsin Bureau of Endangered Species planted Mead’s milkweed seedlings in seven restoration sites (Richard Anderson, Wisconsin Bureau of Endangered Species, pers. comm. 2002). Surveying of existing prairie remnants for potential milkweed restoration should continue in this region.

Kansan glaciation (Kansas) This region is located north of the Kansas River in Kansas and includes four extant populations. One of the occurrences, the Rockefeller Prairie, is “A” ranked and contains a high number of genotypes. The second largest population in this region is French Creek hay meadow, which has a high number of ramets but a low number of genotypes.

Kansan glaciation (Missouri) This region is located north of the Missouri River in Missouri. Only three, one “C” and two “D” ranked, populations occur in this region. Each population consists of a few ramets comprised of single clones.

Kansan glaciation (Iowa) Iowa populations occur on clay-loam and silty-clay loam mollisols covered with a layer of loess developed from weathered Kansas drift (Freeman 1988). All seven of the Mead's milkweed populations that are extant in Iowa occur in this region. Most of the populations are found on private property and consist of a few ramets. Because of their small habitat sizes, these populations may require metapopulation management.

Illinoisian glaciation (Iowa & Illinois) Mead's milkweed is no longer extant in this region, however potential restoration sites occur in Illinois and possibly in Iowa. Restoration efforts have begun in this region of Illinois. Surveying of existing prairie remnants for potential milkweed restoration should continue in this region.

Wisconsonian glaciation (Illinois & Indiana) In 2001, the only remaining occurrence from this region, a railroad prairie population, was plowed (Bowles *et al.* 2001a). Mead's milkweed restoration efforts have been started in this region of Illinois and Indiana. Prairie remnants should be surveyed for potential milkweed restoration in this region.

Status of Restored Populations

The Morton Arboretum in Lisle, Illinois, has maintained a genetically diverse garden population of Mead's milkweed by planting seeds from extant populations and herbarium specimens representative of Kansas and western Missouri populations (Bowles *et al.* 1993). Beginning in 1994, Bowles and others began using these plants in prairie restoration projects in Illinois, Indiana, and Wisconsin (Bowles *et al.* 1998; Bowles *et al.* 2001a, 2001b). These restorations are in the physiographic regions where the species is otherwise extinct. In Illinois and Indiana, over 2000 seeds and juvenile plants from 50 different seed sources and crosses have been planted. This effort has led to the establishment of over 500 Mead's milkweed plants, of which about 60% were planted as 1-year-old juveniles and 40% were from planted seeds (Bowles *et al.* 2001b). In 2001, 100 plants were given to the Wisconsin Bureau of Endangered Species and divided among seven restoration sites (Richard Anderson, pers. comm. 2002).

Restoration experiments suggest that planting juvenile plants may be more effective than planting seeds. When grown in a greenhouse, seeds had a 74% germination rate whereas only 33% of seeds planted in the field germinated. Planted juveniles have also been the only plants to flower, which may occur after 12 years. Plants grown from seeds however, have shown almost no growth and may take 15 years or more to reach reproductive size (Bowles *et al.* 2001a). In addition, seedlings are more susceptible to drought stress (Bowles *et al.* 1998).

HABITAT

Plant community

The primary habitat of Mead's milkweed is mesic to dry mesic, upland tallgrass prairie, characterized by vegetation adapted for drought and fire (Axelrod 1985; Barbour and Billings 1988; Ellsworth 1922; Van Bruggen 1959; Freeman 1988; Roosa *et al.* 1989). Mead's milkweed populations are generally restricted to full sun in late-successional or virgin grassland; however plants may also persist vegetatively in partial shade, such as in edges of glades or barrens that are being encroached upon by woody vegetation (Betz and Hohn 1978; Schwegman 1987; Bowles *et al.* 1998; Phillippe *et al.* 2000;). Populations typically occur on mesic to dry-mesic, upland tallgrass prairies (Ellsworth 1922; Van Bruggen 1959; Freeman 1988; Roosa *et al.* 1989). Mead's milkweed has also been found on glades or barrens (Steyermark 1940; Steyermark 1977; White 1978). Appendix 5 summarizes the natural community types and land uses for all extant populations. Populations in Kansas, Iowa, and Illinois have been classified as dry-mesic to mesic prairie. Populations in Missouri, however, have been classified as sandstone, chert, or shale prairie with the exception of igneous glades in Iron and Reynolds counties (Steyermark 1940, 1977). Southern Illinois sites are classified as sandstone barrens (White 1978).

Mead's milkweed occurs with many of the same common species throughout its range (Appendix 6). Some species such as big and little bluestem grass (*Andropogon gerardii* and *Andropogon scoparius*) and prairie dropseed (*Sporabolus heterolepis*) are found in both prairie and barren milkweed habitats. However, due to the different natural communities and land uses across the milkweed's range there are some plant associates that are more specific to those conditions. For example, in southern Illinois barrens habitat, Mead's milkweed plant associates also include poverty oat grass (*Danthonia spicata)*, June grass (*Koeleria cristata*), eastern eulophus (*Perideridia americana*), pencil flower (*Stylosanthes biflora*), slender pinweed (*Lechea tenuifolia*), Drummond St. John's wort (*Hypericum drummondii*), potato dandelion (*Krigia dandelion*), woodland sunflower (*Helianthus divaricatus*), slender bush (*Lespedeza virginica*), old-field goldenrod (*Solidago nemoralis*), and flowering spurge (*Euphorbia corollata*) (Kurz and Bowles 1981). In the St. Francois Mountains of Iron and Reynolds Counties, Missouri, habitat conditions appear similar to southern Illinois. However, fewer tallgrass prairie species are present, and dominant species in open glade habitat include rushfoil (*Crotonopsis elliptica*), little bluestem (*Andropogon scoparius*), flowering spurge (*Euphorbia corollata*), wild onion (*Allium mutable*), three awn (*Aristida* sp.)**,** and panic grass (*Panicum lanuginosum*) (Doug Ladd, The Nature Conservancy, pers. comm. 1996).

Due to the rarity of tallgrass prairie habitat, some areas where Mead's milkweed occurs also support other species listed as threatened or endangered under Federal and State laws. The Mead's milkweed is associated with the western prairie fringed orchid (*Platanthera praeclara*) (Sheviak and Bowles 1986), a federally threatened plant, on at least six sites in Kansas, one Missouri site, and two Iowa sites (Freeman and Brooks 1989). Numerous Kansas and Missouri prairies with Mead's milkweed also support populations of the prairie mole cricket (*Gryllotalpa major* Saussure), formerly a Federal species of concern (Figg and Calvert 1987; USFWS 1992).

Soils and Substrate

Mead's milkweed usually occurs between 800-1200 feet above sea level on middle and upper portions of slopes less than 20 percent (Freeman 1988). Such habitats are often described as dry-mesic and represent a wide range of landlords and substrates. The southern part of this species' range is unglaciated, and soils are developed in loess or residual material from underlying sandstone, chert, dolomite, shale, and igneous bedrock. These soils are comparatively acidic and nutrient poor. In the northern part of its range, soils are developed in glacial drift often with a deep mantle of loess. A single population found in the driftless area of Wisconsin probably occurred in loess over dolomite. These soils are calcareous and high in nutrients and organic matter. Soils in Kansas habitats have intermediate pH levels, nutrients, and organic matter. In general, Missouri and southern Illinois sites are acid and nutrient poor, Kansas sites are intermediate, and Iowa and northern Illinois sites are calcareous and nutrient-rich (Table 2).

Table 2. Geographic differences in soil chemistry and nutrient status of habitats supporting Mead's milkweed. Data are means and ± standard errors (Bowles *et al.* 1998). (OM = Percent organic matter, CEC = cation exchange capacity, pH, P = Parts per million (ppm) Phosphorous, K = ppm Potassium, MG = ppm Magnesium, and Ca = ppm Calcium concentrations)

Region	No. of Sites	Community	% OM	CEC	pH	P	K	MG	Ca
Illinois/ Iowa	7	Prairie	11.09 ±1.51	20.64 ±1.24	6.67 ±0.31	6.7 ±1.24	229 ±33.22	412.9 ±41.14	2992.9 ±348.11
Kansas	7	Prairie/Hay Meadow	5.54 ±0.36	15.27 ±1.32	6.47 ±0.29	1.71 ±0.47	75.43 ±15.75	255 ±14.43	2200 ±285.15
Missouri/ S. Illinois	6	Hay Meadow/ Glade	5.05 ±0.80	5.05 ±0.91	5.67 ±0.35	6.67 ±0.51	73.0 ±9.57	116.67 ±22.35	758.33 ±216.57

In southern Illinois, populations occur in dry barrens with a western exposure on bluffs at the northern end of the Shawnee Hills. The bluffs are on an escarpment 400 feet above the Saline River lowlands to the northwest (Voigt and Mohlenbrock 1964; Alverson 1981; Kurz and Bowles 1981).

Extant Iowa populations occur on clay-loam and silty clay-loam mollisols developed from weathered Kansan-age drift and covered with a moderate to thick loess mantle (Freeman 1988). These populations are situated on Pennsylvanian bedrock. Historical populations in Clinton and Scott Counties may have occurred on Cretaceous or Silurian bedrock (Freeman 1988).

Kansas populations are on well-drained silty and silty-loam mollisols derived from loess, residuum, limestone, shale, and infrequently with glacial till or sandstone (Freeman 1988). These soils are represented by the Summit-Lula-Woodson, Woodson-Kenoma, Parsons-Dennis, Grundy-Pawnee, Martin-Pawnee-Sogn, and Sharpsburg-Ladoga-Knox soil series (Freeman 1988). Underlying bedrock is of Pennsylvanian age and includes the Shawnee, Douglas, Lansing, Kansas City, and Marmaton Groups (Freeman 1988).

Missouri populations occur mostly on soils of the Haig-Hartwell-Deepwater, Newtonia-Summit-Barco-Sneed, and Liberal-Barco-Collinsville series (Morgan 1980). These soils were formed from loess, glacial till, limestone, sandstone, and shale. Underlying geologic strata are of Ordovician, Mississippian, or Pennsylvanian age and include the Marmaton and Cherokee Groups (Morgan 1980). Average soil characteristics reported by Morgan (1980) include a soil depth of approximately 10 inches (25.4 cm), pH of 5.4, and a loam texture. In the St. Francois Mountains, populations occur in soils developed over Precambrian igneous bedrock. These populations occur between 1500-1700 ft. above sea level.

SPECIES BIOLOGY

Life History

Mead's milkweed is a perennial herb that flowers annually throughout its adult life. The plants are long-lived and may persist indefinitely until destroyed by chance impacts from animals or pathogens. Plants marked along railroads in Missouri in 1966 persisted almost 30 years until the sites were destroyed. Similarly, several plants established in restored prairie at the Morton Arboretum have persisted since 1966 (Betz 1989). Mead's milkweed have low reproductive rates but substantial longevity surviving in habitat between competitive bunch grass and stable late-successional prairie (Bowles and Bell 1998). For example, in a 7-year study conducted by Betz (1989), only 6.4 % of flowering stems produced seed pods. Growth projections on seedling cohorts suggest that Mead's milkweed will require decades to mature from a germinating seed to a flowering plant and that demographic processes may be as slow as in some woody plants (Bowles *et al.* 2001a). Because plants are slow to reach reproductive maturity, their longevity is an important life-history strategy and has apparently sustained populations in hay meadows where mowing results in the removal of fruits before they mature and release seeds (Freeman 1988; Bowles *et al.* 1998; Tecic *et al.* 1998). As a result, seedling establishment may be infrequent but is probably required for long-term population maintenance and necessary for population establishment.

Mead's milkweed begins flowering from late May in the south and mid-June in the north (Betz 1967; J.E. Schwegman, pers. comm. 1988). Severe drought can cause loss of flowers and potential seed production or wilting and dying back of an entire plant. Stressed plants may be reduced to sterile or juvenile conditions or dormancy. Milkweed pollen is dispersed in pollen sacs, or pollinia, by insects (Betz 1967; Betz and Hohn 1978; Bookman 1981; Kephart 1981; Shannon and Wyatt 1986; Betz *et al.* 1994). Mead's milkweed is pollinated by small

bumblebees (*Bombus* sp.) and miner bees (*Anthophora* sp.), and its seeds are wind dispersed from follicles (Betz 1989; Betz and Lamp 1992; and Betz *et al.* 1994). No data are available on the dispersal patterns and distances that Mead's pollinia may be transported. For most milkweeds, pollen appear to be transferred short distances within colonies (Pleasants 1991), but occasional long-distance pollen transfers often result in usually large neighborhood sizes, or areas of genetic exchange (Shannon and Wyatt 1986; Broyles and Wyatt 1993a; Wyatt and Broyles 1994). Mead's milkweed also spreads vegetatively through rhizomes. Observations in the field and in potted plants reveal that Mead's milkweed has an underground rootstock that produce multiple ramets from which rhizomes grow up to approximately 39 inches (1 meter) long (M.L. Bowles, Morton Arboretum, pers. obs.).

Most milkweeds are either self-incompatible or highly sensitive to inbreeding depression and require outcrossing by insects between sexually compatible plants for production of viable seeds (Kephart 1981; Shannon and Wyatt 1986; Kahn and Morse 1991; Broyles and Wyatt 1993b). Therefore, Mead's milkweed capability to sexually reproduce has been reduced in small or genetically invariant populations. For example, viable seeds have not been found in most populations located east of Kansas and western Missouri. High rates of pod abortion or loss of biotic agents may further reduce the percentage of seed production. In a 7-year study (1965-1971) of more than 100 Mead's milkweed ramets in Missouri railroad prairies, Betz and Lamp

(1992) found that percent flowering ramets ranged from 58% to 94%, but that only 6.4% of the flowering ramets produced mature seed pods. Over the 7-year period, average seed production ranged from 55-68 seeds per pod, while percent seed germination ranged from 38-51% (average = 47.6%). McGregor (1987) found between 60-80 seeds per pod based on herbarium specimens.

Population genetics

Mead's milkweed is genetically diverse, and maintains about 74% of its genetic variation within populations (Tecic *et al*. 1998). As a result, large natural populations have high reproductive and evolutionary potential. While diversity of alleles may be high within populations, there may be a low number of different genotypes to insure successful crossing within populations (Tecic *et al.* 1998; Hayworth *et al.* 2001). A small proportion of unique alleles also occurs among different populations, making small populations important genetic resources. Because its obligate out-crossing breeding system requires crossing between genetically different individuals (genotypes), populations that are small, clonal, or have few genotypes have low reproductive potential. These conditions indicate that viable natural or restored populations should have high levels of genetic diversity and high numbers of genotypes to promote successful reproduction and evolutionary potential.

There seems to be no strong correlation between genetic differentiation and geographic distribution patterns of Mead's milkweed (Tecic *et al.* 1998). That is somewhat surprising because this species is widely distributed over areas where soil conditions range from acid and nutrient-poor in the south to calcareous and nutrient-rich in the north (Bowles *et al.* 1998). Successful field experiments introducing seeds from nutrient poor areas from Missouri and Kansas into the nutrient-rich soils of northern Illinois suggest that these soil differences may not be critical to the species (Bowles *et al.*1998). The high level of genetic diversity, and long-distance pollen transfer and seed dispersal characteristic of Mead's milkweed may maintain its capacity to perform well in diverse habitats.

Genetic analyses found that most small eastern populations were composed of single genets that may be incapable of sexual reproduction, leaving them vulnerable to extirpation (Tecic *et al.* 1998). Mead's milkweed populations exhibit minor annual fluctuations in ramet numbers (Betz and Hohn 1978; Freeman 1988; Betz 1989). The status of individual ramets and genets may shift between flowering, non-flowering, or not appearing above ground. Environmental fluctuations, such as rainfall, or biological factors, such as seed production or pathogens, may be factors in this variation; however, differences in land management and use may also affect population structure. Bowles *et al.* (1998) found that ramet densities are higher in mowed sites, but flowering occurs at a higher frequency in sites that are burned rather than mowed (Table 3). Thus, hay mowing may promote vegetative spread of Mead's milkweed and loss of genotypes, and burning may promote or allow flowering and sexual reproduction. The greater number of genotypes in burned sites assures greater chances of successful outcrossing and sexual recombination.

The different effects of fire and mowing on demographic structure can be used to develop a general model for estimating population structure. For example, genets were spatially isolated at the Rockefeller Prairie, and the area occupied by individual genets was less than 5.5 feet (1.7 meters) in diameter, or less than 7.5 square feet (0.697 square meters) (Alexander *et al.* 1997).

Table 3. Comparison of burning and mowing effects on genetic population structure of Mead's milkweed in burned prairies and hay meadows. Genetic data based on allozymes isolated from tissue collected in Kansas and Missouri in 1993 and 1994. (Tecic *et al.* 1998).

	Weimer Hill	Rockefeller	Coyler	Sunset	Creek	Hinton Garnett	Niawathe	Jack's
Treatment	Burn		Hay Meadow					
Sample size	48	21	12	10	15	21	22	18
No. of genotypes	27	15	9	9	9	8	8	5
Mean % ramets/genet	3.7	6.7	11.1	11.1	11.1	12.5	12.5	20.02
± standard error	±0.4	±0.5	±1.2	±1.1	±1.2	±1.7	±2.3	±6.2

Thus, ramets occurring within about 39 inches (1 meter) of each other probably belong to the same genet in burned prairies. In hay meadows, ramets are also spatially isolated, but occupied larger areas, usually more than 33 square feet (3.067 square meters) (Bowles *et al.* 1995). Thus, ramets occurring within about 6.5 feet (2 meters) of each other probably belong to the same genet in hay meadows. Intermediate distances may characterize clones in glade habitat (Bowles *et al.* 1995). The clonal patterns of Mead's milkweed often can be estimated by understanding its management history.

Factors affecting population size and structure

Research on restoring Mead's milkweed has also shown that juvenile plants and seedlings have significant yet different reactions from rainfall levels and prescribed burning. In 1996, a year with twice the average May through July rainfall, seedling survivorship was three times higher than years with normal rainfall (Bowles *et al*. 1998; Bowles *et al*. 2001a). In that same year seedling survivorship was also higher in burned than in unburned plots suggesting that seedling establishment is enhanced by a combination of greater than average rainfall and fire. Juvenile survivorship however, was not higher in 1996 but was higher after prescribed burns during years of normal rainfall. This research also found that sites that had been burned produced larger juvenile and flowering plants as well as an increase in flowers (Bowles *et al*. 1998; Bowles *et al*. 2001a). Because of the plant's longevity, it is too early to draw conclusions from on-going field experiments; however, none of the introduced seedlings have progressed to the reproductive stage.

Invertebrate interactions

Few data are available on the effects of insects to Mead's milkweed survival and mortality. In greenhouse or garden propagation, seedlings and young plants are susceptible to damage from insect pests such as aphids (*e.g. Myzus persicae*) and thrips (*e.g. Frankiniella tritici*) (Betz and

Hohn 1978; Betz 1989). The extent to which these factors result in mortality in nature is unknown but probably low. Nearly all of the fauna observed on Mead's milkweed probably cause little harm to healthy populations when not present in excessive numbers. These include the monarch butterfly (*Danaus plexippus*), milkweed harlequin moth (*Euchaetias egle*), and golden milkweed caterpillar moth (*Cycnia tenera*), all species with caterpillars that feed on the leaves. Both the adults and grubs of the milkweed chrysomelid beetle (*Labidormera clivicollis*) also feed on the leaves. In addition, both the adults and nymphs of milkweed bugs (*Lygaeus kalmii* and *Oncopeltus fasciatus*) feed on the pods (Betz 1989).

More severe damage can be caused to Mead's milkweed by the milkweed cerambycid beetles (*Tetraopes* sp.), whose adults feed on the leaves and flowers. Their larvae, which feed on the roots, could kill the plant. Other potentially damaging insects are the milkweed weevils (*Rhyssematus* sp.). The adult females of this genus girdle the flowering stems causing the umbel to collapse and fall downward (Betz 1989). In addition, the adult females of this genus insert their eggs into the stem, where their grubs feed on the pith tissue (Robert Betz, Northeastern Illinois University, pers. comm. 1989). Both the ovipositing of the females and the grubs feeding within the stem can weaken the stem or topple the umbel, thereby preventing seed production.

REASONS FOR LISTING AND CONTINUING THREATS

Mead's milkweed is threatened by the destruction and alteration of tallgrass prairie due to intense agricultural use, urban growth, and urban residential, industrial, and commercial development, recreational use of sites, and hay mowing that disrupts the species' sexual reproductive cycle. Predation, pathogens, intrinsic biological factors, such as sexual incompatibility, and unpredicted catastrophes also may threaten small populations that have been isolated by fragmentation and are incapable of sexual reproduction and population recovery.

Habitat loss and modification represent the greatest threat of the past, present, and future (Betz and Hohn 1978; Kurz and Bowles 1981; Sheviak 1981; Brooks 1983; Mohlenbrock 1983; Watson 1983; Evans 1984; Freeman 1988). This species' requirement of late-successional tallgrass prairie makes it vulnerable to habitat disturbances that alter habitat conditions or successional stages. This habitat requirement also limits its restoration to small sites, because large late-successional sites do not exist in the eastern part of the species range (Bowles and Bell 1998). Restoration of large high-quality prairies is also not a short-term process, and has not been attained even after 20 years (Schramm 1992). As a result, available habitat size may regulate population growth by limiting effective population size and reproductive potential. Development of an inordinately large or dense population within a small area could result in density-dependent disease or insect infestations that would have disastrous effects on populations.

Destruction of tallgrass prairie habitat began with European settlement and continues. Confirmed sites have been destroyed by plowing and land development in Kansas (Freeman 1988), Iowa (Watson 1983), and Illinois (Kurz and Bowles 1981). In 1989, the Elkins Prairie hay meadow, which supported large populations of Mead's milkweed and the threatened western prairie fringed orchid, was destroyed due to pressure from expanding land development near

Lawrence, Kansas (Bill Harrison, U.S. Fish and Wildlife Service, pers. comm.1991). Almost all of the Missouri and Kansas railroad prairie populations studied by Betz (1989) between 1965-71 have been destroyed either due to a shift from burning to use of herbicides to maintain railroad right-of-ways, or use of these habitats for utility projects. The railroad prairie habitat for the single population of Mead's milkweed in Illinois' Grand Prairie was abandoned and reverted to local private ownership and was destroyed in 2001 (Bowles *et al.* 2001a). The Saline County, Illinois milkweed colonies are threatened by introduced plants, woody vegetation encroachment, trampling by hikers (Kurz and Bowles 1981; Schwegman 1987) and theft. In 1991, 5 of 12 plants were stolen from a population that was an experimental restoration (Stone 1991). The incident received national publicity (Stone 1991), and a $5000 reward was offered for information leading to the perpetrators.

Prevention of sexual reproduction by hay mowing results in altered population structure and reduction in genetic diversity and evolutionary potential. All but one of the Kansas milkweed populations occur on privately owned prairie hay meadows (Freeman 1988). Mowing of these prairies typically occurs in late June to early July (Brooks 1983; Freeman 1988), removing immature fruits and preventing completion of the plant's life cycle. Private Missouri hay meadows receive similar management. Missouri public prairies that contain Mead's milkweed were acquired from private hay meadow holdings beginning in the late 1970's. Mowing is continued on these sites, but in rotation with burning and resting, and occasionally grazing (Smith 1996).

Habitat fragmentation has reproductively isolated most Mead's milkweed populations, even in Kansas and Missouri where populations are most numerous (Freeman 1988). Smaller habitat fragments support lower numbers of plants, and thus, fragmentation may hasten or explain the loss of genotypes and failure to sexually reproduce. Low plant numbers may not attract sufficient pollinators in some populations, and the serious loss of habitat in the eastern portion of the species' range may have reduced pollinator populations, especially miner bees (*Anthophora* sp.) that appear to have been the primary pollinators (Betz *et al.* 1994).

In contrast to pre-European settlement times when more extensive populations were present, insect predation may limit survival and reproduction in small populations of Mead's milkweed (Betz 1989). The most damaging insect impacts are caused by milkweed beetles (*Tetraopes* sp.) and milkweed weevils (*Rhyssematus* sp.). Milkweed beetles penetrate roots and stems, which can weaken adult plants and cause reversion to juvenile states. Milkweed weevils topple flower heads, which can prevent reproduction.

Genetic diversity may override many other factors impeding recovery of Mead's milkweed, especially in eastern populations where the number of genetically different plants appears to be very low and possibly limited to one genotype per population. High numbers of genetically different individuals will be required to overcome self-incompatibility or inbreeding depression and maximize reproductive and evolutionary potential in restored or recovered populations (Tecic *et al*. 1998). Thus, infusion of genetic material from across the range of the species will be required in most restoration or recovery efforts. Long-distance crossing has the potential for disrupting naturally evolved lineages and causing outbreeding depression by breaking up locally co-adapted gene complexes; however, the increased vigor of growth, survival, and fertility that may result from such crosses might outweigh deleterious consequences (Fenster and Dudash 1994). Although outbreeding depression may occur in milkweed species, no evidence has been found for optimal outcrossing because of their usually large neighborhood sizes (Broyles and Wyatt 1991).

CONSERVATION MEASURES

Mead's milkweed was listed as a threatened species under the Act on September 1, 1988 (USFWS 1988). Conservation measures provided to Mead's milkweed as a listed threatened species under the Act , include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private agencies, groups, and individuals. The Act provides for possible land acquisition and cooperation with the States and requires that recovery actions be carried out for all listed species.

Section 7 of the Act requires Federal agencies to consult with the Service if any action they may fund, authorize, or carry out may affect listed species. Section 7 also requires that these agencies use their authorities to further the conservation of federally listed species. This consultation process promotes interagency cooperation in finding ways to avoid or minimize adverse effects to listed species or to compensate for unavoidable adverse impacts.

Sections 9 and 10 of the Act and the corresponding implementing regulations found at 50 CFR 17.71 and 17.72 set forth a series of prohibitions and exceptions that apply to all threatened plant species not covered by a special rule. No special rule has been published for Mead's milkweed. These prohibitions, in part, make the following activities illegal for any person subject to the jurisdiction of the United States: import or export; transport in interstate or foreign commerce in the course of a commercial activity; sell or offer for sale this species in interstate or foreign commerce; remove and reduce to possession this species from areas under Federal jurisdiction; and maliciously damage or destroy this species on any other area in knowing violation of any State law or regulation or in the course of any violation of a State criminal trespass law. The term "plant" means any member of the plant kingdom, including seeds, roots and other parts. Because Mead's milkweed is a threatened plant species, seeds from cultivated specimens are exempt from these prohibitions provided that a statement of "cultivated origin" appears on their containers. Certain exceptions apply to agents of the Service and State conservation agencies.

The Act provides for the issuance of permits to implement otherwise prohibited activities involving threatened species under certain circumstances. Such permits are available for scientific purposes or to enhance the propagation or survival of the species. Requests for copies of the regulations on plants and inquiries regarding them may be addressed to: Permits Coordinator, Division of Endangered Species, U.S. Fish and Wildlife Service, 1 Federal Drive, Fort Snelling, Minnesota 55111-4056 (phone: 612-713-5350, fax: 612-713-5292). TTY users may contact the Permits Coordinator through the Federal Relay Service at 1-800-877-8339.

Protection afforded Mead's milkweed populations at the State level is variable (Table 4), with full protection provided only in Iowa. In Missouri, Mead's milkweed populations are protected only on public land. Over 30% of the populations in Missouri are currently in public ownership or protected by private conservation groups. There is no protection of Mead's milkweed in Kansas, and only four Kansas populations are on public land or owned by conservation groups. The Iowa populations are protected by public law, but only two sites are in public ownership and are being managed. Two sites are private hay meadows, two are private pastures, and another is in the right-of-way of an abandoned railroad prairie that is threatened by adjacent land use. As in Missouri, Mead's milkweed is protected only on public land in Illinois, and its removal from any site requires permission of the landowner. The Saline County sites are federally owned and are located within the Shawnee National Forest. Mead's milkweed populations receive various forms of protection through public ownership, formal agreements from private landowners, or

legal dedication through permanent conservation easements under State nature preserve acts. Because of their permanence, the highest forms of protection are legal dedications that declare the land set aside declaring its highest and best use to be conservation, and protection from other forms of government use, development, or use for public utility projects (Pearsall 1984). Such dedications can be made by private or public landowners and thus do not require transfer of property ownership. Once habitats are protected, land management is the most important and most useful tool for conservation of the Mead's milkweed. Landowners can receive management assistance or management advice from professional land managers and the Service.

Table 4. Listing status and level of protection for Mead's milkweed by State.

State/Status	**Protection Act**	**Level of Protection**
Illinois/ Endangered	Endangered Species Protection Act	Prohibits removal without permission of landowner, and sale without permit; requires consultation between the Department of Natural Resources and State and local agencies authorizing or funding impacts on listed species
Iowa/ Endangered	Management and protection of endangered plants and animals (109A)	Prohibits taking, possessing, importing, exporting, transporting, processing, selling, or buying of any State or Federal listed plant.
Kansas	No legal protection	Not applicable
Missouri/ Endangered	Endangered Species Law	Prohibits exportation, transportation, or sale of endangered plants. Requires consultation between Department of Conservation and State and local agencies authorizing or funding actions impacting State listed species.

RECOVERY STRATEGY

The Recovery Strategy for Mead's milkweed is to restore, manage, and preserve viable populations containing the genetic variability found across its range, thereby insuring reproductive and evolutionary potential and long-term persistence of the species. Therefore, we need to articulate distinguishing characteristics of viable populations.

Conserving viable populations of plant species requires that they have a high probability of long-term persistence within natural habitats. A minimum viable population (MVP) is usually the smallest population size capable of persisting over a specified time period (100 years) with a low extinction probability (less than 5%), and with sufficient genetic variation to adapt to changing environmental conditions (Soule 1980; Menges 1991, 1998; Brown 1994; Pavlik 1994; Bell *et al.* 2002). To do so, populations must survive extinction risks from natural disasters and from environmental, genetic, and demographic variation while demonstrating stable or positive population growth rates (Gilpin and Soule 1986) measured by demographic changes in mortality, survivorship, and fecundity (Menges 1986, 1991). An important aspect of such demographic analysis is the identification of critical life history stages that have the greatest effect on population growth and analysis of the biological and ecological causes of variation in these stages (Pavlik 1994; Schemske *et al.* 1994). Estimating minimum viable population sizes is difficult for plant species such as Mead's milkweed because they have cryptic clonal growth, low reproductive rates, long-distance seed dispersal, and great longevity (Menges 1991). As a result it can be difficult to assess the viability of plant populations. Viability is most accurately expressed as a combination of parameters related to population structure (age classes, sizes, reproductive status) and habitat condition (patch size, management condition, or protection status, etc.) (Pavlik 1994).

Six characteristics affect population viability of Mead's milkweed (Table 5). Because Mead's milkweed is a long-lived rhizomatous perennial, its populations have persisted in many tallgrass prairie remnants, even in some small fragments in the eastern parts of its range. Further examination of its life history characteristics helps explain the persistence of these populations. The species' life history makes populations vulnerable to habitat modifications that range from total destruction to overuse, such as by grazing or annual mowing. In relation, research indicates that restoration of Mead's milkweed is most successful in late successional habitat because of its structure (Bowles *et al.* 2001a). As a result, restoration attempts will probably require high-quality prairie conditions. High genetic diversity within Mead's milkweed populations should be maintained in managed populations and replicated in restorations to maximize their capacity for reproduction and evolutionary potential. This requirement places restored populations at a disadvantage until a high level of genetic diversity can be established and may require management of smaller populations as metapopulations to maintain and benefit from high regional levels of genetic diversity. The outcrossing breeding system of Mead's milkweed has made it extremely vulnerable to habitat fragmentation. A high level of genetic diversity within populations, as much as 50 genotypes, is needed to insure compatible outcrossing (Bowles and Bell 1998). Furthermore, pollinator populations must be healthy in order to have sustainable reproduction.

Table 5. Factors affecting Mead's milkweed population viability (Bowles and Bell 1998).

Factor	Effect on viability
Requires late-successional habitat	Vulnerable to habitat disturbance and limited habitat availability
Mead's milkweed is genetically diverse, and maintains about 74% of its genetic variation within populations.	Large natural populations have high reproductive and evolutionary potential
Plants are genetically self-incompatible and are subject to inbreeding depression	Natural or restored populations with few genotypes have low reproductive potential
Requires insect pollination by bees	Absence of pollinators will prevent reproduction
Long-lived adult stage	Small populations can have long-term persistence
Extremely low rates of seed production, seedling survivorship, and growth	Population restoration is an extremely slow process

The characteristic low reproductive output of this species complements its long-lived life history strategy but constrains its potential for rapid population growth, either in managed or restored populations. The seedling life history stage of this species appears to be highly vulnerable to biological and environmental factors and further constrains population growth.

Criteria for assessing viability of Mead's milkweed populations
Population Viability Analysis has been used to assess over 100 plant populations many of which are endangered and threatened plants (Fiedler 1987; USFWS 1999; Menges 2000; Bell *et al.* 2002). Bowles and Bell (1998) have identified seven biological and habitat variables that affect population viability of Mead's milkweed. These variables are combined in a population viability index (Table 6) that can be used to target recovery actions that will reduce the chances of population extirpation to acceptable levels. The index may be refined as further research provides insight into factors affecting viability. The variables are defined below.

Population size strongly affects the potential for population persistence of Mead's milkweed. The larger the population the greater likelihood that there will be genetically different and sexually compatible individuals. Populations with more than 50 mature plants are given the highest value of 3, 25-<50 are given a value of 2, 10-<25 are assigned a 1 and less than 10 individuals would be given the lowest value of 0.

Population growth trend indicates whether the population size is stable, increasing, or decreasing. Values are determined by levels of cohort survivorship proportional to growth from seedling to mature size classes. A population with a rating of 3 is increasing in size and maturity and sexually reproducing. A population receives a rating of 2 if the plants have flowered, but have failed to produce seeds. A population receives a rating of 1 if it is stable but lacks mature plants.

Table 6. Determination of population viability index (PVI) for Mead's milkweed. PVI = [A+B+C+ D+E+F+G]/21. Values for each variable range from 0-3, and PVI ranges from 0-1. Low viability $\leq$ 0.50, moderate viability = 0.50-.75, and high population viability = 0.75 (Bowles and Bell 1998).

Variable	Range of Ranking			
	0	1	2	3
A. Population size	< 10	10-< 25	25-< 50	> 50
B. Population growth trend2	no measure or < survivorship and < growth	either + survivorship or + growth	flowering\no seeds + survivorship > growth	seeds produced + survivorship > growth
C. Effective population size/# of genotypes	< 10	10-< 25	25-< 50	> 50
D. Habitat size	< 1 hectare	1-<25 hectares	25-<50 hectares	>50 hectares
E. Habitat condition/ successional stage	very heavily disturbed	heavily disturbed early successional	mod. disturbed mid-successional	lightly disturbed/late-successional
F. Protection status	none	informal	formal	legal
G. Management condition	severe	moderate	low	none

A Size based on total population census.

B Trend based on occurrence of flowering, seed production, stable (+) or declining (<) cohort survivorship, and increasing (>), stable (=) or declining (<) life stage transitions.

C Based on allozyme or molecular measures of the number of genotypes present

D Area of potential habitat.

E Based on natural quality grades. Lightly or undisturbed = grade A, moderately disturbed = grade B, heavily disturbed = grade C, very heavily disturbed = grade D.

F Function of ownership and deed restrictions. None = private ownership with no protection, informal = private ownership without legally binding protection, formal = private or public ownership with formal but not legal protection, legal = private or public ownership with legally binding protection.

G Degree of management needed due to habitat degradation from fire protection and woody plant succession, exotic species invasion, hydrology alteration, and other land use impacts.

Populations receiving a rating of 0 are too small to measure or have had a decrease in survivorship and decrease in level of maturity.

Effective population size is based on the number of reproductively compatible Mead's milkweed in the population determined by the seed source or assays of multi-allelic or molecular genotypes such as random amplified polymorphic DNA (RAPD). Populations with more than 50 genotypes have a higher capability to successfully cross-pollinate and are given the highest value. Populations with 25 to 50 genotypes are placed in the second category, 10 to 25 in the third, and less than 10 in the lowest category.

Habitat size can influence a population's ability to survive by the amount of potential habitat available and indirectly by creating a buffer from negative influences outside the habitat. The capability of Mead's milkweed to persist is low in sites smaller than 1 hectare (2.5 acres), and 50 hectares (125 acres) is a threshold for maintenance of large numbers of plants, maximizing reproduction potential, and high levels of genetic diversity.

Vegetation condition and successional stage is a qualitative assessment of vegetation stability in relation to past or current disturbance regimes. Because Mead's milkweed are restricted to virgin prairies, populations are considered more stable in late-successional vegetation in which the vegetational structure is that of stable bunch grass.

Protection status values represent the level of ownership and legal deed restrictions for the property in which the habitat is on. Public or private land protected under legal conservation easements, such as dedication under the Illinois Nature Preserve Act, have highest protection at the State level (Pearsall 1984) and are given a value of 3. Habitats in public ownership that are not legally protected may have formal protection status but can be subject to management or use that could conflict with Mead's milkweed habitat maintenance and would be given a value of 2. Private land not protected by legal conservation easements might have informal protection, such as volunteer registry programs and land owner agreements, but long-term land use remains at the discretion of the land owner and are given a value of 1. Mead's milkweed populations on sites that are not legally or formally protected should not be relied upon to meet the recovery criteria and are therefore given a value of zero for this variable.

Management condition is the degree of management needed as a result of habitat degradation from fire suppression, woody plant and non-native plant invasion, changes in hydrology, and other impacts to Mead's milkweed habitat. Values assigned are primarily based on a determination of the need for and frequency of fire management to conserve a late-successional graminoid vegetation structure. Fire-managed habitats that are free of woody vegetation invasion are considered highly viable and would receive a value of 3. Management conditions that have greater suppression requirements would be considered less viable and would receive a lower value.

PART II. RECOVERY

RECOVERY OBJECTIVE

The recovery objective is to delist the Mead's milkweed. To accomplish delisting, a minimum number of populations should be preserved, managed, and restored in plant communities representing the range of the species' habitats and geographic distribution. Populations are considered preserved when they are given the highest available legal protection. Specific management goals are: 1) maintain natural areas that are large enough to support Mead's milkweed dynamics in relation to late-successional habitats, 2) use management techniques that mimic natural processes and prevent invasions of non-native plant species, and 3) maintain and increase genetic diversity across the range and within populations. Specific recovery and restoration goals are as follows: 1) recover extant populations of Mead's milkweed to viable population levels throughout the species range, and 2) introduce new populations and restore to viable levels in regions where populations have been extirpated.

RECOVERY CRITERIA

Mead's milkweed may be removed from the List of Endangered and Threatened Wildlife and Plants when the following criteria have been satisfied.:

1. Twenty-six populations are distributed across plant communities and physiographic regions within the historic range of the species (See Table 7 for distribution of these populations).

2. Each of these 26 populations is highly viable. A highly viable population is defined as follows: more than 50 mature plants; seed production is occurring and the population is increasing in size and maturity; the population is genetically diverse with more than 50 genotypes; the available habitat size is at least 125 acres (50 hectares); the habitat is in a late-successional stage; the site is protected through long-term conservation easements, legal dedication as nature preserves, or other means; and the site is managed by fire in order to maintain a late-successional graminoid-vegetation structure free of woody vegetation (Bowles and Bell 1998).

3. Monitoring data indicates that these populations have been stable or increasing for 15 years.

Table 7 presents a framework for identifying the states, physiographic regions, and communities in which Mead's milkweed must be preserved or restored in order to recover the species. Table 7 also displays the number of extant populations along with the minimum number of highly viable populations required in each State and physiographic region to achieve recovery. The number of highly viable populations required for recovery varies from one to four, based on the extent of the physiographic region and former distribution of Mead's milkweed in each State.

Populations may be restored in natural plant communities, restorations of native plant communities, or and late-successional communities managed to maintain milkweed populations. Habitats for restored populations should have the maximum legal protection available, such as nature preserve dedication or other forms of deed restriction. Restored populations would need to be monitored over time to determine their ability to persist through natural disturbances and drought cycles. Protection of peripheral populations, even small ones, may be important in preserving the genetic variability of the species.

Table 7. Number of Mead's milkweed populations needed to meet recovery criteria and number of extant populations in the United States by State, physiographic region, and plant community. Viability of extant populations has not been determined.

State	Physiographic Region	Community	Recovery Criteria	Extant Populations
Illinois	Grand Prairie	Tallgrass Prairie	2 highly viable	0
Illinois	Shawnee Hills	Glades/Barrens	1 highly viable	4
Illinois	Western Forest-prairie	Tallgrass Prairie	1 highly viable	0
Indiana	Grand Prairie	Tallgrass Prairie	1 highly viable	0
Iowa	Southern Iowa Drift Plain	Tallgrass Prairie	3 highly viable	7
Iowa	Western Forest-prairie	Tallgrass Prairie	1 highly viable	0
Kansas	Glaciated Region	Tallgrass Prairie	2 highly viable	8
Kansas	Osage Plains	Tallgrass Prairie	4 highly viable	93
Missouri	Glaciated Plains	Tallgrass Prairie	2 highly viable	3
Missouri	Osage Plains	Tallgrass Prairie	3 highly viable	36
Missouri	Ozark Border	Tallgrass Prairie	1 highly viable	3
Missouri	Ozark-Springfield Plateau	Tallgrass Prairie	3 highly viable	10
Missouri	Ozark-St. Francois Mountains	Glades/Barrens	1 highly viable	7
Wisconsin	Driftless	Glades/Barrens	1 highly viable	0
TOTALS			26 highly viable	171

STEPDOWN OUTLINE

1. Protect habitat
   - 1.1 Contact landowners and encourage conservation
   - 1.2 Seek legal dedication
   - 1.3 Increase number of sites managed or owned by conservation organizations

2. Manage habitat
   - 2.1 Conduct management assessment of public and private lands
   - 2.2 Perform prescribed burns on a regular basis in habitat with extant populations
   - 2.3 Control invasive species in habitat with extant populations of Mead's milkweed

3 Increase size and number of populations
   - 3.1 Assess genetic condition of extant populations
     - 3.1.1 Estimate the number of ramets and genotypes by collecting morphological data
     - 3.1.2 Determine if genetic lineages occur among populations
     - 3.1.3 Increase genetic diversity by introducing seeds or plants
   - 3.2 Select sites for introduction and restoration
     - 3.2.1 Select sites for augmentation based on variables in population viability index
   - 3.3 Introduce or restore new populations, historic sites, and newly identified habitat
     - 3.3.1 Establish new populations using seeds or plants

4 Conduct field surveys for new population occurrences or potential habitat for introduction
   - 4.1 Eastern Kansas - Osage Plains Physiographic Region
   - 4.2 Western Missouri - Osage Plains Physiographic Region
   - 4.3 Western Missouri - Ozark Border Physiographic Region
   - 4.4 Western Missouri - Ozark-Springfield Plateau Physiographic Region
   - 4.5 Southeast Missouri - Ozark-St. Francois Mountains Physiographic region
   - 4.6 Northern Kansas - Glaciated Physiographic Region
   - 4.7 Northern Missouri - Glaciated Plains Physiographic Region
   - 4.8 Southwest Iowa - Southern Iowa Drift Plain Physiographic Region
   - 4.9 Eastern Iowa - Western Forest-prairie Physiographic Region
   - 4.10 Western Illinois - Western Forest-prairie Physiographic Region
   - 4.11 Southern Illinois - Shawnee Hills Physiographic Region
   - 4.12 Southwest Wisconsin - Driftless Physiographic Region
   - 4.13 Northern Illinois - Grand Prairie Physiographic Region
   - 4.14 Northwest Indiana - Grand Prairie Physiographic Region
   - 4.15 Update site occurrence information annually and provide information to State surveys and Service

5. Conduct research on restoration, management, and introduction techniques
   - 5.1 Evaluate response to different prescribed fire regimes
   - 5.2 Evaluate the use of herbicide to control invasive species

5.3 Determine the effects of different hay mowing regimes/intervals
5.4 Conduct studies on seedling ecology and establishment
5.5 Conduct studies on juvenile plant ecology and establishment
5.6 Assess survivorship and growth of backcrosses from genetically distant sources
5.7 Determine Mead's milkweed pollinators and their management needs
5.8 Identify external factors affecting life history stages

6. Maintain conservation populations.
   6.1 Collect and store seeds
   6.2 Grow and maintain plants

7. Promote public understanding.
   7.1 Produce a fact sheet and make it available on Service website.
   7.2 Hold workshops on managing Mead's milkweed sites
   7.3 Create a traveling display
   7.4 Promote news reports and press releases

8. Review and track recovery progress
   8.1 Assess the viability of each population

NARRATIVE OUTLINE FOR RECOVERY ACTIONS

1 Protect habitat

An urgent need for recovery of Mead's milkweed populations is protection of their habitat. Habitat condition and protection status are two determinants of a population's level of viability. Land use practices that prevent reproduction and disturb habitat negatively affect the viability of a population. In order to achieve recovery for the Mead's milkweed, management that is beneficial to survival and reproduction should be promoted. Legal dedication of habitat by conservation organizations provides binding protection and a greater likelihood of beneficial management. However, legal protection and proper management of habitat requires a commitment by each party involved. Therefore, a prioritization of sites based on a population's potential to become highly viable and contribute to recovery should be considered. Protection through conservation easement, acquisition and dedication, or other protection should be sought for Mead's milkweed populations within each physiographic region that have high viability or potential to become highly viable. If populations do not occur within a region, habitat should be identified and restored. Reduced habitat size and habitat availability across most of the species range may constrain the potential for populations to become highly viable. Combinations of populations in these regions may need to be managed as groups to maintain at least 50 genotypes within populations and insure their viability.

1.1 Contact landowners and encourage conservation

All landowners should be informed of the presence of Mead's milkweed populations on their property, the species' Federal and State listing status, the levels of protection afforded by Federal and State law, population management needs, and management assistance available from the Service and State agencies. Information provided to landowners should include non-technical educational materials that explain why the Mead's milkweed is federally listed and what the species management needs are. Private landowners should be informed of the options and incentives for legal protection.

1.2 Seek legal dedication

In most states, the highest available form of legal protection consists of conservation easements under State nature preserve acts (Pearsall 1984). Such dedications can usually be made by private or public landowners, and thus they do not require transfer of property rights. Because the majority of Mead's milkweed populations do not have such legal protection, landowner contact and subsequent protection under State nature preserve acts provides a highly effective method for protecting habitat. For states that do not have active nature preserve acts, other forms of conservation easements can be held by private organizations. If established, such easements should provide management for the habitats and plant communities associated with the Mead's milkweed and should allow access for monitoring.

1.3 Increase number of sites managed or owned by conservation organizations

Another protection option to willing owners is conveyance of property rights to public or private conservation organizations that will provide legal protection and management. For example, The Nature Conservancy manages eight parcels of private land with Mead's milkweed populations, and two of these are "A" ranked populations. The assurance of proper management of milkweed habitat on these lands provides a greater potential for these populations to persist and thrive.

2 Manage habitat

Once Mead's milkweed populations are protected, habitat management becomes a critical recovery factor. Sites supporting milkweed populations may require varying degrees of active management to maintain or enhance populations. For example, management needs for Mead's milkweed include replacement of summer hay mowing with dormant season burning, avoidance of severe growing season disturbances such as overgrazing, and maintenance of late-successional vegetation. Management techniques needed may include prescribed burns, brush removal, and herbicide application.

2.1 Conduct management assessment of public and private lands

Survey all extant Mead's milkweed populations identified in Appendixes 1, 2, and 3 for ecological conditions maintaining milkweeds and to assess and identify management needs. Additional sites also may be assessed to determine their recovery potential. Specific management problems should be identified and resolved, and determinations should be made as to the recovery potential of each site.

2.2 Perform prescribed burns on a regular basis in habitat with extant populations

Contact conservation organizations that own and/or manage Mead's milkweed habitat and establish a rotational prescribed fire management regime. In general, extant sites that are not managed by fire or hay mowing are encroached upon by trees and shrubs. As encroachment continues, preferred habitat becomes shaded, and population numbers decline. Therefore, prescribed fire and removal of woody vegetation are management tools that should be used. Prescribed burns should take place between the end of October and the end of March to stimulate flowering.

2.3 Control invasive species in habitat with extant populations of Mead's milkweed

Contact conservation organizations that own and/or manage Mead's milkweed habitat and establish an invasive species control program. Sites with extant populations that are not managed are being encroached upon by invasive species. As encroachment continues, competition in preferred habitat increases, and population numbers decline. In addition to prescribed fire, removal of invasive species through herbicide application, biological control, and manual and mechanical brush removal should be used. In order to avoid negative impacts to Mead's milkweed, treatments should take place between the end of October and the end of March.

3 Increase size and number of populations

In order to recover the Mead's milkweed, the number and genetic diversity of plants within extant populations must increase and new populations have to be introduced. Increasing the size of potential habitat through woody vegetation removal may help augment populations by allowing the persistence of habitat-size restricted animal species that contribute to habitat disturbance and creation of regeneration niches. An important objective for Mead's milkweed population management or restoration is infusion of high levels of genetic diversity that will allow sexual recombination. Ideally, the introduction of genetic material should follow genetic patterns found to occur at a local scale within and among populations. Smaller populations might be limited in pollinator visits and volume of seed production. Introduction of juvenile plants or seeds may help augment populations lacking in natural reproduction. However, seedling establishment appears to occur most readily in late-successional habitat and may take as long as 15 years to reach sexual maturity.

3.1 Assess genetic conditions of extant populations

A census of ramets and genets is needed to determine each population's size and recovery potential. Collection and analysis of plant tissue will be needed to determine genetic lineages among populations. This information will help assist in determining the feasibility of long distance crosses in order to increase genetic diversity within populations. Populations that are genetically invariant will require infusion of large numbers of genotypes to restore reproductive ability and will need an increase in population size to avoid loss through stochastic events. Augmentation of populations should be accomplished by introducing seeds and plants from conservation populations.

3.1.1 Estimate the number of ramets and genotypes by collecting morphological data

A baseline ramet and genet census of all populations not yet studied should be conducted, preferably within a single growing season. For each population, this census should record total numbers of flowering and vegetative ramets and should estimate genet numbers based on ramet distribution patterns. A second census should be conducted prior to hay mowing to determine numbers of ramets with seed pods as a further estimate of population reproductive potential. Determination of the genetic variability within and among populations will provide an accurate estimate of population size and recovery potential.

3.1.2 Determine if genetic lineages occur among populations

Understanding genetic lineages among Mead's milkweed populations may be important for guiding the use of different seed sources in enhancing genetic diversity in populations and introducing new populations. However, genetic material for lineage analysis of the Illinois, Indiana, and Wisconsin populations is not available as these populations are essentially extirpated. Therefore, genetic analysis should be conducted in order to determine appropriate seed source.

3.1.3 Increase genetic diversity by introducing seeds or plants

The Morton Arboretum in Lisle, Illinois has established a nursery population and propagule source of Mead's milkweed for population restoration. The seed sources for these plants came from multiple sites in Missouri and Kansas. This collection method should be expanded to include genetic material from Illinois and Iowa populations. Seeds should be used to increase genetic diversity and augment extant populations that are legally protected, are properly managed, and have mid to low genetic diversity. If seedling establishment is successful, appearance of flowering plants may occur in as little as 15 years.

Experimental planting of 1-year old juvenile plants from the Morton Arboretum nursery population have been successful with a few plants flowering and producing seeds within 6 years. In addition, seeds that are germinated in a greenhouse have a higher rate of return than planting seeds in natural sites. Small extant populations that have low genetic diversity and are in habitat that is managed and owned by conservation organizations should be planted with juvenile plants in order to increase population size and genetic diversity.

3.2 Select sites for introduction and restoration

When population restoration is needed to meet recovery criteria for a particular State or physiographic region, the Service coordinates the selection of sites for restoration actions among appropriate agencies. As with extant populations, these sites should meet the recovery criteria of having legal protection and minimum size and management needs so as to be able to achieve at least moderate viability. Because the potential for restoration of Mead's milkweed habitat is not well known, restoration attempts should be monitored and analyzed in order to provide information that will guide other restorations.

3.2.1 Select sites for augmentation based on variables in population viability index

Apply the variables used to assess the viability of Mead's milkweed populations (Table 6) in the selection of sites for introduction and restoration. The variables used to determine a population's viability are population size; population growth trend; effective population size and number of genotypes; habitat size; habitat condition and successional stage; protection status; and management condition. The Service will then coordinate the selection of priority sites for recovery actions among various agencies. Multiple populations are available to select from in some physiographic region and plant community categories. In these instances, final site selection is not provided by this Plan, but should be made by the appropriate agency in agreement with the Service.

3.3 Introduce or restore new populations, historic sites, and newly identified habitat

As with recovery of existing populations that are not reproducing, introduced populations should contain high numbers of genotypes and should be large enough to buffer against stochastic environmental or demographic events that might destroy smaller populations. As with small natural populations, genetic material should be provided from crosses among local populations and from the appropriate Kansas and Missouri populations as determined by genetic analysis

3.3.1 Establish new populations using seeds or plants

The Morton Arboretum in Lisle, Illinois has established a nursery population and propagule source of Mead's milkweed for population restoration. Seeds from this collection or from other sites should be used to introduce Mead's milkweed into new sites. Selection of other seed sources should be based on habitat types of the donor and receptor sites.

Experimental planting of 1-year-old juvenile plants has been successful with a few plants flowering and producing seeds within 6 years. Because juveniles reach sexual maturity much faster than planted seeds, they are the optimal introduction technique. Juvenile plants should be introduced from the Morton Arboretum or other sources on appropriate habitat that is located on protected land and managed by a conservation organization.

4 Conduct field surveys for new population occurrences or potential habitat for introduction

Field surveys should be conducted to determine if additional Mead's milkweed populations exist. This information is needed to insure that the highest priority populations are protected across the range of the species and to insure that population restoration goals are appropriate. Because of the presence of appropriate habitat, new prairies and new populations may be identified in southern Illinois, eastern Kansas, southwest Missouri, and in the St. Francois Mountains of southeastern Missouri. Although little habitat is present in northern Illinois, southern Iowa, and northern Missouri these areas may support undiscovered small populations in prairie remnants of old cemeteries and along roadsides and railroad rights of way. Searches should also take place in regions of states where Mead's milkweed is believed to be extirpated for potential habitats where introduction of juvenile plants and seeds could take place.

4.1 Eastern Kansas - Osage Plains Physiographic Region

All of the counties from which Mead's milkweed was historically found in the Osage Plains of eastern Kansas still have extant populations. However, most of these populations occur on privately owned hay meadows. Undiscovered extant populations may exist. Potential habitat for introduction and restoration of Mead's milkweed may also exist. Searches for additional populations and habitat should be conducted in southeastern tallgrass prairies with dry-mesic to mesic conditions.

4.2 Western Missouri - Osage Plains Physiographic Region

The majority of Mead's milkweed populations in Missouri occur in the Osage Plains Region. The natural habitat in this region is tallgrass prairie, but most of the populations occur in fields that have been converted to hay meadows. As may be the case throughout the species' range, the Missouri Department of Conservation (Smith 1996) suggests that there are additional sites and suitable habitat that have not been discovered or reported in remnant prairie habitats along roadsides, railroad rights of way, in old cemeteries, and hay meadows. Therefore, searches for extant populations should be conducted in various prairie remnants of this region.

4.3 Western Missouri - Ozark Border Physiographic Region

The natural community and habitat type for Mead's milkweed in this region is dry-mesic chert tallgrass prairie. Currently, only three extant populations occur in this region; each occurs in private hay meadows of Pettis County, Missouri. Efforts to protect these populations need to be taken, as discussed under number 1 above. In addition, there may also be other populations and additional habitat for introduction and restoration on private land as well as remnant prairies; therefore, searches should be conducted.

4.4 Western Missouri - Ozark-Springfield Plateau Physiographic Region
Six of the 10 extant populations in this region occur in private hay meadows. The other four are under the ownership and management of The Nature Conservancy and Missouri Department of Conservation. Additional efforts need to be made to conserve the unprotected populations, as discussed under number 1 above. In addition, there may also be other populations and additional habitat for introduction and restoration on private land as well as remnant prairies. Areas that should be searched in this region for new populations or habitat potential include dry-mesic chert and sandstone/shale tallgrass prairies.

4.5 Southeast Missouri - Ozark-St. Francois Mountains Physiographic Region
Additional occurrences of Mead's milkweed probably exist in the extensive glade or barrens habitat of the St. Francois Mountains of Iron County, Missouri, and adjacent counties. Most of this habitat is in public ownership and provides the opportunity for management of a large milkweed metapopulation. Surveys should be conducted by the Missouri Department of Conservation, Missouri Department of Natural Resources, and U.S. Forest Service on their respective properties, and private land should be surveyed to the extent possible.

4.6 Northern Kansas - Glaciated Physiographic Region
Efforts need to be taken to locate additional populations and habitat for restoration and introduction on private land, as well as remnant prairies of northern Kansas. Mead's milkweed natural community and habitat type in this region is dry-mesic to wet-mesic northeastern tallgrass prairie. Currently, seven extant populations occur in private hay meadows, and one protected site is managed as an ecological reserve. These populations can be found in Jefferson and Leavenworth Counties of Kansas.

4.7 Northern Missouri - Glaciated Plains Physiographic Region
Discoveries of new milkweed populations in Harrison and Adair Counties of glaciated northern Missouri indicate that small fragmented populations may still occur in this primarily agricultural landscape on public and private lands. Surveys for milkweed populations or potential habitat should focus on hay meadows and cemetery and railroad tallgrass prairies remnants with mesic conditions.

4.8 Southwest Iowa - Southern Iowa Drift Plain Physiographic Region
Discoveries of new milkweed populations in glaciated southwest Iowa indicate that small fragmented populations still occur in this primarily agricultural landscape. Watson (1998) reports that potential habitat is dispersed between the southwest corner of Iowa eastward to Scott County. Surveys should focus on hay meadows and

tallgrass prairie remnants in cemetery and railroad prairies that might contain milkweed populations.

4.9 Eastern Iowa - Western Forest-prairie Physiographic Region

Mead's milkweed is extirpated in this region. Surveys for small populations and potential habitat need to be concentrated in remnant prairie habitat of pioneer cemeteries and along roadsides and railroad rights of way of eastern Iowa. In addition, Watson (1998) suggests that potential habitat may still exist in the bedrock outcrop and hill prairies along the Mississippi River from Clayton to Jackson Counties.

4.10 Western Illinois - Western Forest-prairie Physiographic Region

Mead's milkweed is believed to be extirpated in this area of Illinois. However, it is possible that suitable habitat and small populations have not been discovered or reported in remnant prairie habitats along roadsides, railroad rights of way and in old cemeteries. Even though this potential may exist, it is essential to locate suitable habitat and introduce Mead's milkweed in order to recover the species in this region.

4.11 Southern Illinois - Shawnee Hills Physiographic Region

Small unknown milkweed populations may still occur in the Shawnee Hills of Saline County, Illinois. Extant populations occur in the sandstone glades and barren habitat of the Shawnee National Forest. Periodic surveys for persisting milkweed colonies should be conducted in these areas and on private land, particularly after prescribed burns in the Shawnee Hills. In addition, potential habitat for introduction of Mead's milkweed needs to be identified.

4.12 Southwest Wisconsin - Driftless Physiographic region

In 2001, habitat was identified in Columbia, Dane, Grant, Green, and Iowa counties of Wisconsin, and Mead's milkweed was introduced at seven restoration sites. Otherwise, the species is extirpated in this region of Wisconsin. Additional glade barren habitat should be identified in order to initiate additional introduction projects. Efforts should be concentrated in Grant County, the only historically recorded county with Mead's, as well as other counties in the Driftless Physiographic Region of Wisconsin.

4.13 Northern Illinois - Grand Prairie Physiographic Region

Mead's milkweed no longer exists in this region; however, small unknown milkweed populations may still remain in pockets of tallgrass prairie habitat along railroads or in cemetery prairies. Introduction efforts are currently taking place at several sites in northern Illinois. Searches for additional habitat should take place to assist in this effort.

4.14 Northwest Indiana - Grand Prairie Physiographic Region

Small unknown milkweed populations may remain in pockets of tallgrass prairie habitat, railroad prairies, or cemetery prairies. Porter County is the only county with a historical record in Indiana. Introduction efforts are currently taking place at one site, Biesecker Prairie, in northern Indiana. Searches for additional habitat should take place to assist in this effort.

4.15 Update site occurrence information annually

Site occurrence information should be kept and updated annually by the appropriate State agencies and Service field offices. Information should be shared among offices in the same State, as well as with the Service's Chicago Illinois Field Office, so that progress toward recovery can be properly coordinated.

5 Conduct research on restoration management and introductions techniques

To develop proper management guidelines for Mead's milkweed, effects of different prairie management regimes on the reproduction, survivorship, and population growth of this species should be determined. This research should assess Mead's milkweed restorations underway in Illinois, Indiana and Wisconsin and should be expanded by initiating and monitoring restorations throughout the range of the species.

5.1 Evaluate response to different prescribed fire regimes

Prescribed burning is the primary management tool used to maintain tallgrass prairie vegetation in preserves. This tool is also essential for maintenance of glade and barrens habitat in the St. Francois Mountains (Guyette and Cutter 1991) and restoration of habitat that has been nearly lost through fire protection in the Shawnee Hills. Prescribed fire management has shown to be essential for milkweed growth, flowering, survivorship, and probably population viability (Bowles *et al*. 2001b). Fire is applied at different frequencies, intensities, and times to manage for different plants and animals. The effects of these different treatments on Mead's milkweed and its pollinators should be determined. Critical comparisons include spring and fall dormant season burns, frequency of burns, and periods of resting.

5.2 Evaluate the use of herbicide to control invasive species

Herbicides are frequently used to control noxious weeds in hay meadows or pastures adjacent to prairies with milkweed populations. Management and restoration of tallgrass prairie remnants may also require herbicides to control invasive species and encroachment of woody vegetation. The effects of these applications on Mead's milkweed populations should be determined. Methods of applying herbicides that avoid non-target species should be evaluated.

5.3 Determine the effects of different hay mowing regimes/intervals

While it is known that summer mowing prevents seed production, it should also be determined how different mowing regimes affect milkweed reproduction, such as fall mowing after seed dispersal, rotating with prescribed burns, or bi-annual mowing.

5.4 Conduct studies on seedling ecology and establishment

Restoration experiments have indicated a long-term survival rate of 34% for seeds planted in the field. However, these seeds have resulted in non-flowering plants that have achieved very little growth and may take 15 years to reach reproductive size. These same experiments also found that seedling establishment is positively affected by higher (as much as 30%) than normal rainfall and management by prescribed burns; in addition, establishment is more successful when introduction occurs in late-successional stage habitats (Bowles *et al.* 2001a). This research would suggest that some restoration parameters can be controlled by land managers (e.g. conducting prescribed burns, identifying late-successional habitats) while other factors can not (e.g. rainfall). Continued and additional restoration projects should coincide with replication of this research and identification of other possible factors influencing recovery. Research should focus on actions that land managers and conservation organizations can take to identify appropriate habitat, successfully introduce new populations, and restore population viability.

5.5 Conduct studies on juvenile plant ecology and establishment

Mead'S milkweed is most often found in late successional tallgrass prairie, but also occurs in hay meadows and glades or barrens. It has been established at the Schulenberg prairie at the Morton Arboretum. It is thought to be a poor competitor. Research on the conditions needed for seedling establishment is needed.

Restoration experiments have shown that introduction of Mead's milkweed by planting juvenile plants has a higher rate of return than planting seeds. Under controlled conditions, there is a higher germination rate, and plants mature faster. This research also found that planted juveniles had higher survival rates in dry-mesic habitat and late-successional prairies (Bowles *et al.* 2001a). Mead's milkweed ecological dependence on late-successional prairie habitat, coupled with the fact that very little of this type of habitat is available, would suggest that restoration potential is limited throughout its range. Additional restoration experiments are required to identify techniques to restore late-successional prairie structure in degraded habitats and methods for improving introduction of juvenile plants in mid-successional habitat when late-successional habitat is not available.

5.6 Assess survivorship and growth of backcrosses from genetically distant sources

Mead's milkweed is a self-incompatible species. Many of its populations are not sexually reproducing successfully because plants are too genetically similar and it. These populations need an influx of different genetic material to restore reproductive capability. However, inter-population crosses could result in outbreeding depression. Therefore, survivorship and growth of seedlings and backcrosses from genetically distant sources should be assessed to determine if population viability is negatively affected. Future experiments need to identify factors that are necessary for populations to become highly viable by analyzing crosses in later generations and by testing in the field.

5.7 Determine Mead's milkweed pollinators and their management needs

While bumblebees (*Bombus* sp.) appear to be able to pollinate Mead's milkweed, miner bees (*Anthophora* sp.) may pollinate more frequently (Betz *et al.* 1994). Research should be conducted to determine if there are primary and secondary pollinators of Mead's milkweed, and if some species groups, such as miner bees, are more vital to successful pollination. Research is also needed to determine if important pollinators have been lost from most Mead’s milkweed habitats, and if they have been lost, methods to restore pollinators should be developed. Research on different habitat management techniques (e.g. prescribed burn) should assess impacts on pollinators. In addition, this research should determine if the loss of pollinators is responsible for reproductive failure within extant populations of Mead’s milkweed.

5.8 Identify external factors affecting life history stages

Future research should focus on identifying and determining how to manage critical external factors, such as insect herbivores or pathogens, that can significantly reduce reproductive effort in Mead's milkweed.

6 Maintain conservation populations

In order to recover and restore populations of Mead's milkweed, conservation techniques are needed that will allow long-term maintenance of seed collections and will facilitate propagation and translocation of propagules for restoration of populations.

6.1 Collect and store seeds

Representative seeds should be collected from different populations and placed in long-term storage through the Center for Plant Conservation.

6.2 Grow and maintain plants

A genetically diverse propagule source has been established at the Morton Arboretum, in Lisle, Illinois. Plants from different areas are grown, and artificial crosses among plants from different areas have produced a genetically diverse conservation population. This collection can serve as a propagule source for recovery and restoration of populations. Once techniques are developed, local botanic gardens should grow plants representing different geographic areas.

7 Promote public understanding

Public relation programs should be developed to promote understanding of the values and management needs of Mead's milkweed populations in tallgrass prairie.

7.1 Produce a fact sheet and make it available on Service website

A fact sheet similar to those developed for other federally listed prairie species should be developed for Mead's milkweed. The fact sheet should describe the species life history, its current and historic geographic range, educational values, and proper management techniques.

7.2 Hold workshops on managing Mead’s milkweed sites

Workshops should be held for prairie managers and biologists to discuss censussing, monitoring, and management techniques to ensure that proper and consistent techniques are used across the species range.

7.3 Create a traveling display

A traveling display of tallgrass prairie endangered species should be developed for use at "prairie days,” fairs, and meetings in areas within the range of Mead's milkweed.

7.4 Promote news reports and press releases

Information on Mead's Milkweed and other endangered and threatened prairie species should be made available to the public through news reports and press releases.

8 Review and track recovery progress

Progress towards meeting recovery plan goals should be reviewed periodically by holding meetings of Federal and State agency personnel, the recovery team, interested scientists, and others contributing towards the recovery of this species.

8.1 Assess the viability of each population

Populations should be ranked based on variables in the population viability index (Table 6). Recovery goals are based on a set number of highly viable populations.

The information gained will help guide management activities. Updated information should be provided to the appropriate State agencies as well as the Service's Chicago Illinois Field Office.

LITERATURE CITED

Alexander, H.M., N.S. Slade and W.D. Kettle. 1997. Application of mark-recapture models to estimation of the population size of plants. Ecology 78:1230-1237.

Allaby, M., editor. 1998. A dictionary of plant sciences. Oxford University Press, New York, New York. 508 pp.

Alverson, W.S. 1981. Status report on *Asclepias meadii*. Unpublished report to the Wisconsin Department of Natural Resources, Madison, Wisconsin. 4 pp.

American Heritage Dictionary. 1991. 2nd College edition. Houghton Midland, Boston, Massachusetts. 882 pp.

Axelrod, D.I. 1985. Rise of the grassland biome, central North America. Botanical Review 51:163-201.

Barbour, M.G. and W.D. Billings.1988. North American terrestrial vegetation. Cambridge University Press, New York, New York. 434 pp.

Bell, T., M. Bowles and K. McEachern. 2002. Projecting the success of plant restoration with Population Viability Analysis. *In* C. Brigham and M. Schwartz (eds).. Ecological Studies, Population Viability in Plants. Springer Verlag, Heidelberg.

Betz, R.F. 1967. The ecology of *Asclepias*, especially *Asclepias meadii* Torrey, and a study of the factors contributing to their possible extinction as a wild plant. A research proposal to the National Science Foundation, Washington, D.C.

Betz. R.F. 1988. Report on the search to rediscover Mead's milkweed (in Indiana). Northeastern Illinois University, Chicago.

Betz, R.F. 1989. Ecology of Mead's milkweed (*Asclepias meadii* Torrey). Pages 187-191. *In* T.B. Bragg and J. Stubbendieck (eds.). Proceedings of the Eleventh North American Prairie Conference. University of Nebraska, Lincoln.

Betz, R.F. and J.E. Hohn. 1978. Status report for *Asclepias meadii*. Prepared for the U.S. Fish and Wildlife Service, Region 6, Denver, Colorado. 9 pp.

Betz, R.F. and H.F. Lamp. 1992. Flower, pod, and seed production in eighteen species of milkweeds (*Asclepias*). Pages 25-30. *In* D.D. Smith and C.A. Jacobs (eds.). Proceedings of the Twelfth North American Prairie Conference. University of Iowa, Cedar Falls.

Betz, R.F., R.D. Struven, J.E. Wall, and F.G. Heitler. 1994. Insect pollinators of 12 milkweed (*Asclepias*) species. Pages 45-60. *In* R.G. Wickett, P.D. Lewis, A. Woodliffe, and P. Pratt (eds.). Proceedings of the Thirteenth North American Prairie Conference. Canada Department of Parks and Recreation, Windsor, Ontario.

Bookman, S.S. 1981. The floral morphology of *Asclepias speciosa* (Asclepiadaceae) in relation to pollination and a clarification in terminology for the genus. American Journal of Botany 68:675-679.

Bowles, M.L., R.F. Betz and M.M. DeMauro. 1993. Propagation of rare plants from historic seed collections: Implications for species restoration and herbarium management. Restoration Ecology 1:101-106.

Bowles, M.L., J.L. McBride and R.F.Betz. 1995. Mead's milkweed (*Asclepias meadii*) restoration in Illinois and Indiana. Unpublished report to the U.S. Fish and Wildlife Service and the U.S. Forest Service, Barrington, Illinois. 20 pp.

Bowles, M.L. and T. Bell. 1998. Establishing recovery targets for Mead's milkweed (*Asclepias meadii*). Report to the Illinois Endangered Species Board. The Morton Arboretum, Lisle, Illinois.

Bowles, M.L., J.L. McBride and R.F.Betz. 1998. Management and restoration ecology of the federally threatened Mead's milkweed, *Asclepias meadii* (ASCLEPIADACEAE). Annals of the Missouri Botanical Garden 85:110-125.

Bowles, M.L., J.L. McBride and T. Bell. 2001a. Restoration of the federally threatened Mead's milkweed (*Asclepias meadii*). Ecological Restoration 19(4):235-241.

Bowles, M.L., J.L. McBride and T. Bell. 2001b. Restoration status of the Federal threatened Mead's milkweed (*Asclepias meadii*) in Illinois and Indiana. *In* C. Peterson (ed.). Proceedings of the Northern Illinois Prairie Workshop. College of Dupage, Dupage, Illinois.

Brendel, F. 1887. Flora Peoriana: The vegetation in the climate of middle Illinois. J.W. Franks and Sons, Peoria, Illinois.

Brooks, R.E. 1983. Unusual Kansas plants I: Mead's milkweed. Kansas Wildflower Society Newsletter 5:18-20.

Brown, J.S. 1994. Restoration ecology: Living with the prime directive. Pages 355-380. *In* M.L. Bowles and C.J. Whelan (eds.). Restoration of endangered species: Conceptual issues, planning, and implementation. Cambridge University Press, Cambridge, England.

Broyles, S.B. and R.Wyatt. 1993a. Allozyme diversity and genetic structure in southern Appalachian populations of poke milkweed, *Asclepias syriaca*. Systematic Botany 18:18-30.

Broyles, S.B. and R. Wyatt. 1993b. The consequences of self-pollination in *Asclepias syriaca*, a self-incompatible milkweed. American Journal of Botany 80:41-44.

Busby, W.H. 1990. An inventory of three prairie animals in eastern Kansas. Unpublished report to the Kansas Department of Wildlife and Parks, Lawrence, Kansas.

Carruth, J.H. 1877. Centennial catalogue of the plants of Kansas. Transactions of the Kansas Academy of Science 5:54.

Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York, New York. 1262 pp.

Deam, C.C. 1940. Flora of Indiana. Indiana Department of Conservation, Indianapolis, Indiana.

Ellsworth, W. 1922. Parry's catalog of Iowa plants of 1848. Proceedings of the Iowa Academy of Sciences 29:339-344.

Evans, J.E. 1984. Element Stewardship Abstract: Mead's milkweed. The Nature Conservancy, Arlington, Virginia. 6 pp.

Fenster, C.B. and M.R. Dudash. 1994. Genetic considerations for plant population restoration and conservation. Pages 34-62. *In* M.L. Bowles and C.J. Whelan (eds.). Restoration of endangered species: Conceptual issues, planning, and implementation. Cambridge University Press, Cambridge, England.

Fiedler, P.L. 1987. Life history and population dynamics of rare and common mariposa lilies. Journal of Ecology 75: 977-995.

Figg, D.E. and P.D. Calvert. 1987. Status, distribution and life history of the prairie mole cricket, *Gryllotalpa major* Saussure. Report to the Missouri Department of Conservation, Jefferson City, Missouri. 40 pp.

Fitzpatrick, J.T. and M.F.L. Fitzpatrick. 1899. The flora of southern Iowa. Proceedings of the Iowa Academy of Science 6:173-202.

Freeman, C.C. 1988. ESIS workbooks for *Asclepias meadii*. U.S. Fish and Wildlife Service.

Freeman, C.C. and R.E. Brooks. 1989. Status report on *Platanthera praeclara* Sheviak and Bowles (western prairie fringed orchid) in Kansas, Nebraska, and South Dakota. Unpublished report to the U.S. Fish and Wildlife Service, Denver, Colorado. 78 pp.

Gaertner, E.E. 1979. The history and use of milkweed (*Asclepias syriaca* L.). Economic Botany 33:119-123.

Gates, F.C. 1940. Annotated list of the plants of Kansas: Ferns and flowering plants. Kansas State College of Agriculture and Applied Science, Manhattan, Kansas.

Gilpin, M.E. and M.E. Soule.1986. Minimum viable populations and processes of species extinctions. Pages 19-34. *In* M.E. Soule (ed.).. Conservation Biology: The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, Massachusetts.

Gray, A. 1856. Manual of botany, second edition. G.P. Putnam and Company, New York, New York.

Greene, E.L. 1880. Notes of certain silkweeds. Botanical Gazette 5:64-65.

Greene, E.L. 1898. Wisconsin field notes. Plant World 2:37-38.

Greene, W. 1907. Plants of Iowa. Bulletin of the State Horticultural Society. Des Moines, Iowa.

Guyette, R.P. and B.E. Cutter. 1991. Tree-ring analysis of fire history of a post oak savanna in the Missouri Ozarks. Natural Areas Journal 11:93-99.

Hanski, I. A., and M. E. Gilpin. 1997. Metapopulation biology: ecology, genetics, and evolution. Academic Press, Inc. San Diego, California. 512 pp.

Hayworth, D., M. Bowles, B. Schaal and K. Williamson. 2001. Clonal population structure of the Federal threatened Mead's milkweed, as determined by RAPD analysis, and its conservation implications. *In* N. Bernstein and L.J. Ostrander (eds.). Proceedings of the Seventeenth North American Prairie Conference: Seeds for the future, roots of the past. North Iowa Area Community College, Mason City, Iowa.

Horner, P. 2001. Missouri's Threatened and Endangered Species Action Plan: 2001-2006. Unpublished Report for the Missouri Department of Conservation, Natural History Division, Jefferson City, Missouri.

Huett, J.W. 1897. Essay toward a natural history of LaSalle County, Illinois. Flora La Sallensis. Part I.

Jones, G.N. 1952. Type localities of vascular plants. American Midland Naturalist 47:487-507.

Kahn, A.P. and D.H. Morse. 1991. Pollinium germination and putative ovule penetration in self- and cross-pollinated common milkweed *Asclepias syriaca*. American Midland Naturalist 126:61-67.

Kansas Geologic Survey. July 7, 2002. Glossary. http://www.kgs.ukans.edu/Extension/glossary.

Kephart, S. R. 1981. Breeding systems in *Asclepias incarnata* L., *A. syriaca* L., and *A. verticillata* L. American Journal of Botany 68:226-232.

Kettle, W.D., H.M. Alexander and G.L. Pittman. 2000. An 11-year ecological study of a rare prairie perennial (*Asclepias meadii*): Implications for monitoring and management. American Midland Naturalist 14:66-77.

Kurz, D. R. and M. L. Bowles. 1981. Report on the status of Illinois vascular plants potentially endangered or threatened in the United States. Unpublished report for the Natural Land Institute, Rockford, Illinois. 10 pp.

Lapham, I.A. 1857. Catalogue of the plants of the State of Illinois. Transactions of the Illinois State Agricultural Society 2:531.

LeBlanc, C.M. 1988. Report on the status of *Asclepias meadii*, Mead's milkweed, in Indiana. Indiana Division of Nature Preserves, Indianapolis, Indiana.

McDonald, F.E. 1899. Geographic range of *Asclepias meadii* and *Hypericum kalmianum.* Plant World 2:126-127.

McGregor, R.L. 1948. The flora of Douglas County, Kansas. Transactions of the Kansas Academy of Science 51:77-186.

McGregor, R.L. 1987. Vascular flora of Kansas: New records and notes for 1986. Contributions of the University of Kansas Herbarium 21:1-8.

Mead, S.B. 1846. Catalogue of plants growing spontaneously in the State of Illinois, the principal part near Augusta, Hancock County. Prairie Farmer 6:35-36, 60, 93, 119-122.

Menges, E.S. 1986. Predicting the future of rare plant populations: Demographic monitoring and modeling. Natural Areas Journal 6(3):13-25.

Menges, E.S. 1991. The application of minimum viable population theory to plants. Pp. 45-63. *In* D.E. Falk and K.E. Holsinger (eds.). Genetics and Conservation of Rare Plants. Oxford University Press, New York, New York.

Menges, E.S. 1998. Evaluating extinction risks in plant populations. Pp. 49-65. *In* P. L. Fiedler and P. M. Kareiva (eds.) Conservation Biology for the Coming Decade, Second Edition. Chapman and Hall, New York, New York.

Menges, E.S. 2000. Population viability analyses in plants: Challenges and opportunities. Trends in Ecological Evolution 15:51-56.

Mohlenbrock, R.H. 1983. Where have all the wildflowers gone? MacMillan Publishing Company, Incorporated, New York, New York. 239 pp.

Morgan, S.W. 1980. Status report on *Asclepias meadii* Torr. Unpublished manuscript with the Missouri Department of Conservation, Jefferson City, Missouri. 15 pp.

Patterson, H.N. 1876. Catalogue of the phaenogamous and vascular cryptogamous plants of Illinois. Publisher. Oquawka, Illinois. 54 pp.

Pavlik, B.M. 1994. Demographic monitoring and the recovery of endangered plant populations. Pages 322-350. *In* M. L. Bowles and C.J. Whelan (eds.). Restoration of endangered species: Conceptual issues, planning, and implementation. Cambridge University Press, Cambridge, England.

Pearsall, S. 1984. Public dedication of Nature Preserves. Natural Areas Journal 4(1):11-23.

Phillippe, L.R., S.M. Gehlhausen, K.R. Robertson and J.E. Ebinger. 2000. Assessment of the reintroduction potential of federally endangered and threatened plant species to managed sites in Illinois. Pp. 11-22. *In* Technical Report 1999-18. Illinois Natural History Survey, Center for Biological Diversity.

Pleasants, J.M. 1991. Evidence for short-term dispersal of pollinia in *Asclepias syriaca* L. Functional Ecology 5:75-82.

Prior, J.C. 1976. A regional guide to Iowa landlords. Iowa Geological Survey, Educational Series 3, Iowa City, Iowa. 72 pp.

Roosa, D.M., M.J. Leoschke, and L.J. Eilers. 1989. Distribution of Iowa's endangered and threatened vascular plants. Iowa Department of Natural Resources. Des Moines, Iowa. 107 pp. + 2 appendices.

Schemske, D.W., B.C. Husband, M.J. Ruckelshaus, C. Goodwillie, I.M. Parker, and J.G. Bishop. 1994. Evaluating approaches to the conservation of rare and endangered plants. Ecology 75:584-606.

Schramm, P. 1992. Prairie restoration: A twenty-five year perspective on establishment and management. Pp. 69-177. *In* D. D. Smith and C.A. Jacobs (eds.) Proceedings of the Twelfth North American Prairie Conference. University of Northern Iowa, Cedar Falls, Iowa.

Schwegman, J. 1987. Status and management analysis - *Asclepias meadii*. Unpublished document with the Illinois Department of Natural Resources. 7 pp.

Schwegman, J.E., G.D. Fell, M. Hutchison, G. Paulson, W.M. Shepherd, and J. White. 1973. Comprehensive plan for the Illinois Nature Preserves Commission. Part II - The Natural Divisions of Illinois. Illinois Nature Preserves Commission, Springfield, Illinois.

Shannon, T.R. and R. Wyatt. 1986. Pollen germinability of *Asclepias exaltata*: Effects of flower age, drying time, and pollen source. Systematic Botany 11:322-325.

Sheviak, C.J. 1981. Endangered and threatened plants. Pp. 70-187. *In* M. L. Bowles, V.E. Diseasing, J.E. Ebinger, and H.C. Schultz (eds.). Endangered and threatened vertebrate animals and vascular plants of Illinois. Illinois Department of Conservation, Springfield, Illinois.

Sheviak, C.J. and M.L. Bowles. 1986. The prairie fringed orchids: A pollinator-isolated species pair. Rhodora 88:267-290.

Smith, T. 1996. Management guidelines for Mead's milkweed (*Asclepias meadii* Torrey *ex* A. Gray). Missouri Department of Conservation, Jefferson City, Missouri.

Soule, M. E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Pp 111-124. *In* M. E. Soule and B.A. Wilcox (eds.). Conservation Biology: An Evolutionary Perspective. Sinauer, Sunderland, Massachusetts.

Steyermark, J.A. 1940. Spring flora of Missouri. Ovid Bell Press, Fulton, Missouri. 582 pp.

Steyermark, J.A. 1977. Flora of Missouri. Iowa State University Press, Ames, Iowa. 1728 pp.

Stone, R. 1991. The case of the missing milkweed. Science 258:851.

Tecic, D., J.L. McBride, M.L. Bowles and D.L. Nickrent. 1998. Genetic variability in the Federal threatened Mead's milkweed, *Asclepias meadii* Torrey (ASCLEPIADACEA) as determined by the allozyme electrophoresis. Annals of the Missouri Botanical Garden 85:97-109.

Templeton, A.R. 1986. Coadaptation and outbreeding depression. Pp 105 -116. *In* M. E. Soule (ed). Conservation Biology: The Science of Scarcity and Diversity. Sinauer, Sunderland, Massachusetts.

Tracy, S.M. 1888. Catalogue of the phaenogamous and vascular cryptogamous plants of Missouri. Tribune Printing Company, Jefferson City, Missouri.

U.S. Fish and Wildlife Service. 1988. Endangered and threatened wildlife and plants; determination of threatened status for *Asclepias meadii* (Mead's milkweed). Federal Register 53(170):33992-33995.

U.S. Fish and Wildlife Service. 1992. Withdrawal of the proposed rule to list the prairie mole cricket (*Gryllotalpa major*) as threatened. Federal Register 57:2239-2241.

U.S. Fish and Wildlife Service. 1999. Eastern Prairie Fringed Orchid (*Platanthera leucophaea*) Recovery Plan. Fort Snelling, Minnesota. 62 pp.

Van Bruggen, T. 1959. A report on the flora of south-central Iowa. Proceedings of the Iowa Academy of Science 66:169-177.

Voigt J.W. and R.H. Mohlenbrock. 1964. Plant communities of southern Illinois. Southern Illinois University Press, Carbondale, Illinois. 202 pp.

Watson, W.C. 1983. Status report of *Asclepias meadii*. Unpublished report to the Iowa Conservation Commission. Des Moines, Iowa. 11 pp.

Watson, W.C. 1992. Inventory of Southern Iowa for *Asclepias meadii* Torr. Unpublished report to the Iowa Department of Natural Resources, Des Moines, Iowa. 26 pp.

Watson, W.C. 1998. Site census of *Asclepias meadii* Torr. In Iowa. Unpublished report to the Iowa Department of Natural Resources and the U.S. Fish and Wildlife Service, Rock Island, Illinois. 10 pp.

Watson, W.C. 1999. Site census of *Asclepias meadii* Torr. in Iowa. Unpublished report to the Iowa Department of Natural Resources and the U.S. Fish and Wildlife Service, Rock Island, Illinois. 12 pp.

Watson, W.C. 2000. Census and reproductive monitoring of *Asclepias meadii* Torr. at two Southern Iowa Prairies. Unpublished report to the Iowa Department of Natural Resources and the U.S. Fish and Wildlife Service, Rock Island, Illinois. 8 pp.

Watson, W.C. 2001. Census, site surveys and management activities pertaining to *Asclepias meadii* Torrey in Iowa. Unpublished report to the Division of Parks, Recreation and Preserves, Iowa Department of Natural Resources, Des Moines, Iowa. 12 pp.

Webster's New Collegiate Dictionary. Springfield (MA): Merriam -Webster; 1980.

White, J. 1978. Illinois Natural Areas Inventory Technical Report. University of Illinois at Urbana, Department of Landscape, Architecture and Natural Land Institute, Rockford, Illinois.

Woodson, R.E. 1954. The North American species of *Asclepias* L. Annals of the Missouri Botanical Gardens 41:1-211.

Wyatt, R. and T.R. Shannon. 1986. Nectar production and pollination of *Asclepias exaltata*. Systematic Botany 11:326-334.

Wyatt, R. and S.B. Broyles. 1994. Ecology and evolution of reproduction in milkweeds. Revised Ecology and Systems 25:423-441.

ADDITIONAL REFERENCES

Bacone, J.A., T.J. Crovello, and L.A. Hauser.1981. Status report on *Asclepias meadii*. Unpublished report to the Indiana Department of Conservation, Indianapolis, Indiana. 10 pp.

Bare, J.E. 1979. Wildflowers and weeds of Kansas. Kansas: Regents Press of Kansas. 509 pp.

Bowles, M.L. and A. Duxbury. 1986. Report on the status of *Platanthera praeclara* Sheviak and Bowles in Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota. Unpublished report to the U. S. Fish and Wildlife Service, Denver, Colorado. 42 pp.

Bowles, M.L., R.F. Betz, and M.M. DeMauro. 1993. Propagation of rare plants from historic seed collections - implications for rare species restoration and herbarium management. Restoration Ecology 1(2):101-106.

Britton, N.L. and A. Brown. 1896. An illustrated flora of the northern United States, Canada and the British Possessions. Charles Scribner's Sons, New York, New York.

Broyles, S.B. and R. Wyatt. 1991. Effective pollen dispersal in a natural population of *Asclepias exaltata*: The influence of pollinator behavior, genetic similarity, and mating success. American Naturalist 138:1239-1249.

Burk, M.J. 1931. Flowering plants of Black Hawk County, Iowa. Proceedings of the Iowa Academy of Science 38:135-149.

DeMauro. M.M. 1993. Relationship of breeding system to rarity in the lakeside daisy (*Hymenoxys acaulis* var. *glabra*). Conservation Biology 7(3):542-550.

Eilers, L. J. 1971. The vascular flora of the Iowan area. University of Iowa Studies in Natural History 21:1-137.

Eberhart, S.A., E.E. Roos, and L.E. Towill. 1991. Strategies for long-term management of germplasm collections. Pp. 135-145. *In* D.A. Falk and K.E. Holsinger (eds.).Genetics and conservation of rare plants. Oxford University Press, New York, New York.

Fernald, M.L. 1950. Gray's manual of botany. 8th edition. American Book Company, New York. 632 pp.

Gleason, H.A. and A. Cronquist. 1963. Manual of vascular plants of northeastern United States and adjacent Canada. D. Van Nostrand Company, New York, New York. 810 pp.

Great Plains Flora Association. 1977. Atlas of the Flora of the Great Plains. The Iowa State University Press, Ames, Iowa. 600 pp.

Hammrich, J.L. and J.W. Godt. 1990. Allozyme diversity in plant species. Pp. 43-63. *In* A.H.D. Brown, M.T. Clegg, A.L. Kahler, and B.S. Weir (eds.). Plant Population Genetics, Breeding, and Genetic Resources. Sinauer Associates, Sunderland, Massachusetts.

Jones, G.N. and G.D. Fuller. 1955. Vascular plants of Illinois. University of Illinois Press, Urbana and the Illinois State Museum, Springfield, Illinois.

Kartesz, J. T. and R. Kartesz. 1980. A synonymized checklist of the vascular flora of the United States, Canada and Greenland. University of North Carolina Press, Chapel Hill, North Carolina. 498 pp.

Kevan, P.G., D. Eisikowitch, and B. Rathwell. 1989. The role of nectar in the germination of pollen in *Asclepias syriaca*. Botanical Gazette 150:226-270.

Leoschke, M. 1988. Iowa Natural Areas Inventory, Bureau of Preserves and Ecological Services, Department of Natural Resources, Wallace State Office Building, Des Moines, Iowa 50319. Personal communication.

Litzow, M. 1978. *Asclepias meadii* Torr.: A summary of the literature. Unpublished manuscript with the University of Minnesota Landscape Arboretum, Chanhassen, Minnesota. 4 pp.

McGregor, R.L. 1977. Rare native vascular plants of Kansas. Technical Publication of the State Biological Survey Kansas 5:1-44.

Mohlenbrock, R.H. 1986. Guide to the vascular flora of Illinois. Southern Illinois University Press, Carbondale, Illinois. 507 pp.

Mohlenbrock, R.H. and D.M. Ladd. 1978. Distribution of Illinois vascular plants. Southern Illinois University Press, Carbondale, Illinois. 282 pp.

Morgan, S.W. 1984. Selected rare and endangered plants of Missouri. Unpublished manuscript with the Missouri Department of Conservation, Jefferson City, Missouri. 29 pp.

Morrissey, T. 1956. The flora of Pine Hill Prairie relict. Proceeding of the Iowa Academy of Science 63:201-213.

Nicolson, D. and N.H. Russell. 1955. The genus *Asclepias* in Iowa. Proceeding of the Iowa Academy Science 46:211-215.

Noamesi, G.K. and H.H. Iltis. 1957. Preliminary reports on the flora of Wisconsin. Number 40. Asclepiadaceae - Milkweed family. Transactions of the Wisconsin Academy of Science, Arts, Letters 46:107-114.

Nordstrom, G.R., W.L. Pflieger, K.C. Sadler and W. H. Lewis. 1977. Rare and endangered species of Missouri. Missouri Department of Conservation and U.S.D.A. Soil Conservation Service. 129 pp.

Ottawa University. 1978. Endangered and threatened wildlife and plants in the Lake Region Counties. University Print Center, Ottawa University, Ottawa, Kansas. 18 pp.

Pammel, L.H. and C.H. King. 1930. Honey plants of Iowa. Iowa Geologic Survey Bulletin 7. 1192 pp.

Read, R.F. 1976. Endangered and threatened vascular plants in Wisconsin. Technical Bulletin 92. Scientific Areas Preservation Council, Department of Natural Resources, Madison, Wisconsin. 58 pp.

Rodener, B.J., D.A. Hamilton and K.E. Evans. 1978. Rare plants of the Ozark Plateau: A field identification guide. North Central Forest Experiment Station, U.S. Forest Service, U.S. Department of Agriculture, St. Paul, Minnesota.

Rydberg, P.A. 1932. Flora of the prairies and plains of central North America. New York Botanical Garden, New York, New York. 969 pp.

Schoewe, W.H. 1949. The geography of Kansas. Transactions of the Kansas Academy of Science 52:261-333.

Smithsonian Institution. 1975. Report on endangered and threatened plant species of the United States. Committee on Merchant Marine and Fisheries, Serial No. 94-A. 94th Congress, 1st Session, House Document No. 94-51. U.S. Government Printing Office, Washington, DC. 200 pp.

Stevens, W.C. 1948. Kansas wild flowers. University of Kansas Press, Lawrence, Kansas. 463pp.

Swink, F. and G. Wilhelm. 1974. Plants of the Chicago region. 2nd edition. The Morton Arboretum, Lisle, Illinois. 474 pp.

Swink, F. and G. Wilhelm. 1994. Plants of the Chicago region. 4th edition. Indiana Academy of Science, Indianapolis, Indiana. 921 pp.

Thom, R.H. and J.H. Wilson. 1980. The natural divisions of Missouri. Transactions of the Missouri Academy of Science 14:9-23.

U.S. Fish and Wildlife Service. 1975. Threatened or endangered fauna or flora; review of status of vascular plants and determination of critical habitat. Federal Register 40(127): 27823-27924.

U.S. Fish and Wildlife Service. 1976. Endangered and threatened wildlife and plants; proposed endangered status for some 1700 U.S. vascular plant taxa. Federal Register 41(117):24523-24572.

U.S. Fish and Wildlife Service. 1979. Endangered and threatened wildlife and plants; notice of withdrawal of five expired proposals for listing of 1,876 species, and intent to revise 1975 plant notice. Federal Register 44(238):70796-70797.

U.S. Fish and Wildlife Service. 1980. Endangered and threatened wildlife and plants; supplement to review of plant taxa for listing; proposed rule. Federal Register 48(229):53640-53670.

U.S. Fish and Wildlife Service. 1983. Endangered and threatened wildlife and plants; supplement to review of plant taxa for listing as; proposed rule. Federal Register 48(229):53640-53670.

U.S. Fish and Wildlife Service. 1987. Endangered and threatened wildlife and plants; proposal to determine *Asclepias meadii* (Mead's milkweed) to be threatened species. Federal Register 52(203):39255-39258.

Voigt J.W. and R.H. Mohlenbrock. 1985. Prairie plants of Illinois. Illinois Department of Conservation, Division of Forestry. 272 pp.

Wilson, J.H. 1984. Rare and endangered species of Missouri. Missouri Department of Conservation, Jefferson, City, Missouri. 171 pp.

PART III. IMPLEMENTATION

The Mead's milkweed Implementation Schedule summarizes actions and estimated costs for the recovery program. It is a guide for meeting the objectives discussed in Part II of this Plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agency, and cost estimates. When accomplished, these actions should bring about the recovery of the species and protect its habitat. It should be noted that the estimated monetary needs for all parties involved in recovery are identified, and therefore, Part III reflects the total estimated financial requirements for the recovery of this species for the time period noted. The Service's Endangered Species Program is responsible for implementing the tasks marked "USFWS" in the Responsible Party column of the Implementation Schedule, unless otherwise noted. Region 3 is the designated lead Region for this species; however, it also occurs in Region 6.

Priorities in column one of the following implementation schedule are assigned as follows

Priority 1 An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 All other actions necessary to meet the recovery objective.

Key to abbreviations in the Implementation Schedule:

IADNR	Iowa Department of Natural Resources
ILDNR	Illinois Department of Natural Resources
ILNPC	Illinois Nature Preserve Commission
INDNR	Indiana Department of Natural Resources
KSBS	Kansas Biological Survey
KSER	Kansas Ecological Reserves
MA	Morton Arboretum
MDOC	Missouri Department of Conservation
TBD	To be determined
TNC	The Nature Conservancy
UNIV	universities, arboretums and botanic gardens
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service Region 3
WDNR	Wisconsin Department of Natural Resources

MEAD'S MILKWEED IMPLEMENTATION SCHEDULE

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
1	2.2	Perform prescribed burns on a regular basis in habitat with extant populations	Ongoing	IADNR ILDNR ILNPC INDNR KSBS MDOC USFWS WDNR	1,125	37.5	37.5	37.5	
1	2.3	Control invasive species in habitat with extant populations of Mead's milkweed	Ongoing	IADNR ILDNR ILNPC INDNR KSBS MDOC USFWS WDNR	54	18	18	18	
1	3.1.1	Estimate the number of ramets and genotypes by collecting morphological data	10	IADNR ILDNR ILNPC INDNR KSBS MDOC WDNR	50	5	5	5	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
1	3.1.2	Determine if genetic lineages occur among populations	10	IADNR ILDNR ILNPC INDNR KSBS MA MDOC UNIV USFWS WDNR	195	30	30	30	Reduce to 15,000 after year 3
1	3.1.3	Increase genetic diversity by introducing seeds or plants	15	IADNR ILDNR ILNPC INDNR KSBS MA MDOC USFWS WDNR	150	10	10	10	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
1	3.2.1	Select sites for augmentation based on variables in the population viability index	10	IADNR ILDNR ILNPC INDNR KSBS MA MDOC USFWS WDNR	30	3	3	3	
2	1.1	Contact landowners and encourage conservation	Ongoing	IADNR ILDNR ILNPC INDNR KSBS MDOC USFWS WDNR	99	6	6	6	Reduced to 3,000 after year 3
2	1.2	Seek legal dedication	10	IADNR ILDNR ILNPC INDNR KSBS MDOC WDNR	60	6	6	6	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
2	1.3	Increase number of sites managed or owned by conservation organizations	5	IADNR ILDNR ILNPC INDNR KSBS MDOC TNC WDNR	2,500	500	500	500	
2	2.1	Conduct management assessment of public and private lands	4	IADNR ILDNR ILNPC INDNR KSBS MDOC USFWS WDNR	120	30	30	30	
2	3.3.1	Establish new populations using seeds or plants	15	IADNR ILDNR ILNPC INDNR KSBS MA MDOC USFWS WDNR	60	4	4	4	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
2	5.1	Evaluate response to different prescribed fire regimes	15	IADNR ILDNR ILNPC INDNR KSBS MA MDOC UNIV USFWS WDNR	30	2	2	2	
2	5.2	Evaluate the use of herbicide to control invasive species	15	IADNR ILDNR ILNPC INDNR KSBS MA MDOC UNIV USFWS WDNR	30	2	2	2	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
2	5.3	Determine the effects of different hay mowing regimes/intervals	15	IADNR KSBS MA MDOC UNIV USFWS	30	2	2	2	
2	5.4	Conduct studies on seedling ecology and establishment	20	MA UNIV USFWS	100	5	5	5	
2	5.5	Continue studies on juvenile plant ecology and establishment	20	MA UNIV USFWS	400	20	20	20	
2	5.6	Assess survivorship and growth of backcrosses from genetically distant sources	10	MA UNIV USFWS	150	15	15	15	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000) Year 1	Year 2	Year 3	Comments
2	5.7	Determine Mead's milkweed pollinators and their management needs	5	IADNR ILDNR ILNPC INDNR KSBS MA MDOC UNIV USFWS WDNR	15	3	3	3	
2	6.1	Collect and store seeds	15	IADNR ILDNR ILNPC INDNR KSBS MA MDOC UNIV USFWS WDNR	150	10	10	10	
2	6.2	Grow and maintain plants	15	MA	300	20	20	20	
2	7.2	Hold workshops on managing Mead's milkweed sites	5	USFWS	50	10	10	10	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
3	4.1	Survey for new populations in Eastern Kansas - Osage Plains	5	KSBS	15	3	3	3	
3	4.2	Survey for new populations in Western Missouri - Osage Plains	5	MDOC USFWS	10	2	2	2	
3	4.3	Survey for new populations in Western Missouri - Ozark Border	5	MDOC USFWS	5	1	1	1	
3	4.4	Survey for new populations in Western Missouri - Ozark-Springfield Plateau	5	MDOC USFWS	5	1	1	1	
3	4.5	Survey for new populations in Southeast Missouri - Ozark-St. Francois Mountains	5	MDOC USFS USFWS	5	1	1	1	
3	4.6	Survey for new populations in Northern Kansas - Glaciated	5	KSBS	5	1	1	1	
3	4.7	Survey for new populations in Northern Missouri - Glaciated Plains	5	MDOC USFWS	5	1	1	1	
3	4.8	Survey for new populations in Southwest Iowa - Southern Iowa Drift Plain	5	IADNR USFWS	5	1	1	1	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
3	4.9	Survey for new populations in Eastern Iowa - Western Forest-prairie	5	IADNR USFWS	5	1	1	1	
3	4.10	Survey for new populations in Western Illinois - Western Forest-prairie	5	ILDNR USFWS	5	1	1	1	
3	4.11	Survey for new populations in Southern Illinois - Shawnee Hills	5	ILDNR USFS USFWS	5	1	1	1	
3	4.12	Survey for new populations in Southwest Wisconsin - Driftless	5	USFWS WDNR	5	1	1	1	
3	4.13	Survey for new populations in Northern Illinois - Grand Prairie	5	ILDNR USFWS	5	1	1	1	
3	4.14	Survey for new populations in Northwest Indiana - Grand Prairie	5	INDNR USFWS	5	1	1	1	
3	4.15	Update Site Occurrence information annually and provide information to State surveys and USFWS	6	IADNR ILDNR ILNPC INDNR KSBS MDOC USFWS WDNR	6	1	1	1	

Priority #	Task #	Task Description	Task Duration (Years)	Responsible Party	Total Cost	Cost Estimates ($000)			Comments
						Year 1	Year 2	Year 3	
3	5.8	Identify external factors affecting life history stages	15	IADNR ILDNR ILNPC INDNR KSBS MA MDOC UNIV USFWS WDNR	60	4	4	4	
3	7.1	Produce a fact sheet and make it available on Service website.	2	USFWS	4	2	2		May need periodic updates
3	7.3	Create a traveling display	2	USFWS	5	3	2		May need periodic updates
3	7.4	Promote news reports and press releases	2	USFWS	2	1	1		
3	8.1	Assess the viability of each population	Ongoing	IADNR ILDNR ILNPC INDNR KSBS MA MDOC USFWS WDNR	45	15	15	15	Requires periodic updates.

APPENDIX 1
GLOSSARY

allele - One of two or more forms of a gene arising by mutation and occupying the same relative position (locus) homologous chromosomes (Allaby 1998).

chert - Commonly called flint, this is a fined grained, noncrystalline rock made up of silicon dioxide (Kansas Geologic Survey 2002).

clone - A group of genetically identical cells or individuals, derived from a common ancestor by asexual mitotic division (Allaby 1998).

follicles - A dry fruit derived from a single carpel which opens at maturity along one side only (Allaby 1998).

genets and genotypes - The genetic constitution of an organism, as opposed to its physical appearance (phenotype). Usually this refers to the specific allelic composition of a particular gene or set of genes in each cell of an organism (Allaby 1998).

heterosis - The increased vigor or growth, survival, and fertility of hybrids (hybrid vigor). It usually results from crosses between two genetically different, highly inbred lines (Allaby 1998).

inbreeding depression - The decline in vigor in the offspring of organisms that are closely related genetically (Allaby 1998).

loess - Nonstratified sediment composed of silt sized particles derived from glacier materials deposited by the wind (Kansas Geologic Survey 2002).

mesic - applied to an environment that is neither extremely wet nor extremely dry (Allaby 1998).

metapopulation - Set of local populations within some larger area, where typically migration from one local population to at least some other patches is possible (Hanski and Gilpin 1997).

mollisols - Mineral soils, an order identified by a deep mollic surface horizon (well decomposed and finely distributed organic matter) and base-rich mineral soil below. Mollisols form mainly grasslands in areas where moisture may be seasonally deficient (Allaby 1998).

outbreeding depression - Fitness reduction (usually in either fertility or viability) following hybridization. Local populations of a species will often adapt to the local environment, particularly if dispersal is limited. Hybridization between different local populations can sometimes destroy the locally adapted gene complex (Templeton 1986).

outcrossing - To breed organisms that belong to different strains of the same breed (American Heritage Dictionary 1991).

perennation - The vegetative means by where biennial and perennial plants survive periods of unfavorable conditions. The aerial parts die back to a minimum at the onset of unfavorable conditions, and food for the new shoots of the next growing season is stored in underground organs (e.g., rhizomes)(Allaby 1998).

pollinium - A coherent mass of pollen grains, the product of a single anther lobe, transported as a single unit in pollination (Allaby 1998).

polycarpic - having a gynoecium forming two or more distinct ovaries (Webster's New Collegiate Dictionary 1980).

propagule - Any structure that functions in propagation and dispersal (e.g. seeds or spores) (Allaby 1998).

ramet - An individual member of a clone (Allaby 1998).

rhizome - A horizontally creeping underground stem which bears roots and leaves and usually persists from season to season (Allaby 1998).

self-incompatible - Requiring crosses between genetically different individuals to produce viable seeds (Kephart 1981; Shannon and Wyatt 1991; Wyatt and Broyles 1994).

umbel - An inflorescence (flower cluster) in which all of the pedicels (stalk of each flower) arise at the apex of the axis (Allaby 1998).

virgin - Not altered by human activity (Webster's New Collegiate Dictionary 1980).

APPENDIX 2.
ELEMENT OCCURRENCE RANKING (EOR) OF MEAD'S MILKWEED POPULATIONS (OBSERVED 1970-2001)

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
IA	Adair	Woodside Prairie	Private	2	C	3	2001
IA	Clarke	Flaherty Prairie	Private	2	D	2	1989
IA	Decatur	Garden Grove Prairie	Private	2	D	4	1992
IA	Ringold	Tingley Prairie	Private	1	D	4	1992
IA	Taylor	Powell Prairie	Private	1	D	30	6-12-2002
IA	Warren	Great Western Trail, Churchville Prairie	Warren County Conservation Board	1	D	4	1988
IA	Warren	Great Western Trail, Cumming	Warren County Conservation Board	8	D	5	1990
IL	Saline	Saline #1	U.S. Forest Service	1	D	<5	1998
IL	Saline	Saline #2	U.S. Forest Service	1	D	<5	1998
IL	Saline	Saline #3	U.S. Forest Service	1	D	<5	1998
IL	Saline	Saline #4	U.S. Forest Service	1	D	17	1998
KS	Allen	Allen #1	Private	0	D	17	06-16-1986
KS	Allen	Allen #2	Private	0	E	Unknown	06-02-1988
KS	Allen	Paint Brush Prairie	Private	0	C	28	05-13-1989

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
KS	Allen	Wolfpen Creek Prairie	Private	0	D	17	05-13-1989
KS	Anderson	Anderson #1	Private	0	?	100	07-02-2001
KS	Anderson	Anderson #2	Private	0	?	Unknown	05-27-1987
KS	Anderson	Anderson #3	Private	0	?	Unknown	05-19-1987
KS	Anderson	Anderson #4	Private	0	?	Unknown	1987
KS	Anderson	Anderson #5	Private	0	D	Unknown	1987
KS	Anderson	Deer Creek Prairie	Private	0	?	Unknown	05-31-1987
KS	Anderson	Dumped-On Prairie	Private	1	D	3	10-01-1990
KS	Anderson	Garnet Prairie	Private	0	B	122	08-04-1988
KS	Anderson	Lone Elm Prairie	Private	0	?	Unknown	05-26-1987
KS	Anderson	Lone Elm Prairie Southwest	Private	0	?	Unknown	05-25-1987
KS	Anderson	Mont Ida Cemetery Prairie	Private	1	D	4	09-26-1990
KS	Anderson	Mount Zion Cemetery North	Private	0	?	Unknown	05-11-1987
KS	Anderson	Mount Zion Cemetery South	Private	0	D	5	05-07-1987
KS	Anderson	North Rich Prairie	Private	0	?	Unknown	05-30-1987
KS	Anderson	Northeast Garnett Prairie	Private	0	D	4	06-02-1993

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
KS	Anderson	Pipeline Prairie	Private	1	D	2	09-11-1990
KS	Anderson	Pott Creek Prairie	Private	1	C	18	07-10-1988
KS	Anderson/Linn	Puppy Dog Prairie	Private	0	D	6	10-04-1990
KS	Anderson	Selma Prairie	Private	1	B	>100	09-08-1987
KS	Anderson	Southfork Pott Creek Prairie	Private	0	?	Several	06-08-1986
KS	Anderson	Sunset Prairie	Private	0	A	>150	05-26-1988
KS	Anderson	Two Rocks Prairie	Private	1	C	>48	09-08-1987
KS	Anderson	Welda Prairie	Private				
KS	Anderson	Welda Prairie North	Private				
KS	Anderson	Westphalia Prairie	Private	0	C	73	06-15-1989
KS	Bourbon	Bourbon #1	Private	0	?	Rare	1971
KS	Bourbon	Bronson Prairie	Private	1	D	5	06-17-1986
KS	Bourbon	Hinton Creek	Private	0	A	439	05-13-1989
KS	Bourbon	Little Pawnee Prairie	Private	0	D	1	06-21-1990
KS	Bourbon	Ronald Prairie North	Private	0	B	106	05-14-1989
KS	Bourbon	Ronald Prairie South	Private	0	D	10	05-14-1989
KS	Bourbon	Treaty Line Prairie	Private	0	C	45	05-14-1989

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
KS	Bourbon	Uniontown Prairie	Private	0	C	58	06-15-1987
KS	Coffey	Crooked Creek Prairie	Private	0	?	3	06-07-1970
KS	Crawford	Farlington Prairie	Unknown	0	D	13	06-16-1989
KS	Douglas	Baldwin Creek Prairie	Private	0	D	6	07-11-1988
KS	Douglas	Blue Healer Prairie	Private	1	D	18	05-29-1986
KS	Douglas	Colyer Prairie	Private	1	B	150	06-03-1991
KS	Douglas	Corner Prairie	Private	1	C	91	06-12-1988
KS	Douglas	Dry Creek Prairie	Private	0	C	10	08-02-1988
KS	Douglas	Gammagrass Prairie	Private	1	C	86	06-12-1988
KS	Douglas	Jack’s Prairie	Private	0	D	3	08-24-1988
KS	Douglas	Jack’s Prairie South	Private	0	A	329	05-11-1989
KS	Douglas	Kanwaka Prairie South	Private	1	D	2	05-23-1986
KS	Douglas	Kanwaka Prairie West	Private	1	C	24	06-13-1986
KS	Douglas	Leary Prairie	Private	1	C	41	05-27-1986
KS	Douglas	Lecompton Prairie	Private	1	C	36	08-17-1987
KS	Douglas	Pioneer Cemetery Site	Private/Municipal	1	D	11	06-11-1988
KS	Douglas	Rock Creek Prairie	Private	0	D	3	09-08-1988

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
KS	Douglas	Small Lakes Prairie	Private	0	D	2	08-30-1988
KS	Douglas	Spring Creek Prairie West	Private	0	D	9	06-11-1994
KS	Douglas	Triangle Prairie	Private	1	D	5	06-05-1988
KS	Douglas	Turnpike Prairie	Private	1	C	57	05-28-1986
KS	Douglas	Turnpike Prairie East	Private	1	B	93	06-12-1988
KS	Douglas	Violet Hill	Private	1	D	3	05-24-1991
KS	Franklin	Appanoose Prairie	Private	0	D	Unknown	07-20-1988
KS	Franklin	Bend-in-the-Road Prairie	Private	1	D	17	05-30-1986
KS	Franklin	Dead End Prairie	Private	1	D	7	05-30-1986
KS	Franklin	Double Cross Prairie	Private	0	D	3	05-30-1986
KS	Franklin	Elm Grove Prairie	Private	0	D	20	1989
KS	Franklin	Fowler Hill Prairie	Private	0	D	5	06-11-1988
KS	Franklin	Franklin 59 Prairie	Private	0	C	34	06-20-2000
KS	Franklin	Homewood Prairie	Private	0	D	13	05-14-1988
KS	Franklin	Middle Creek Prairie	Private	1	C	30	06-06-1990
KS	Franklin	Mount Hope Prairie	Private	0	C	52	05-30-1986
KS	Franklin	Ohio Prairie	Private	1	C	58	1989

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
KS	Franklin	Pottawatomie Prairie	Private	1	D	15	06-02-1986
KS	Franklin	Silo Prairie	Private	1	C	7	07-17-1999
KS	Jefferson	French Creek Prairie	Private	0	B	180	06-09-1990
KS	Jefferson	Kansas University Ecological Reserve-Rockefeller Native Prairie	State of Kansas	8	A	200	2001
KS	Jefferson	Wild Horse Prairie	Private	1	D	9	07-02-1998
KS	Johnson	Camp Prairie	Private	1	D	10	01-06-1983
KS	Johnson	De Soto Prairie	Private	0	D	11	06-25-1993
KS	Johnson	Kill Creek Prairie	Johnson County	1	C	27	06-25-1993
KS	Johnson	Prairie Center Site	The Nature Conservancy	8	D	11	06-14-1995
KS	Leavenworth	Alexandria Northwest Prairie	Private	1	D	12	05-26-1998
KS	Leavenworth	High Prairie	Private	0	D	13	06-21-1989
KS	Leavenworth	Hilltop Prairie	Private	1	D	3	06-03-1986
KS	Leavenworth	Lonesome Elm Prairie	Private	1	D	1	06-03-1986
KS	Leavenworth	Reno Northwest Prairie	Private	0	?	<5	05-26-1998
KS	Leavenworth	Turnpike Hilltop Prairie	Private	0	?	Unknown	05-21-1998

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
KS	Linn	Blue Mound City Lake	Private	0	?	5	05-24-2000
KS	Linn	Eureka Prairie	Private	0	C	77	5-17-1989
KS	Linn	Linn #1	Private	0	?	1	06-20-1989
KS	Linn	Little Pond Prairie	Private	0	D	9	06-17-1986
KS	Linn	Pleasant Prairie	Private	0	?	6	05-17-1989
KS	Linn	Prescott Prairie	Private	0	D	18	05-15-1998
KS	Linn	Sugar Creek Prairie	Private	0	C	72	06-20-1989
KS	Miami	Bell Branch Prairie	Private	0	D	2	06-20-1990
KS	Miami	Centennial Prairie	Private	0	D	16	06-02-1986
KS	Miami	Highland Prairie	Private	0	D	20	06-02-1986
KS	Miami	Metcalf Prairie	Private	1	B	177	05-16-1989
KS	Miami	Plum Creek Meadow	Private	0	D	4	06-02-1993
KS	Miami	Side Hill Prairie	Private	0	D	1	06-02-1993
KS	Miami	Springview Prairie	Private	0	C	42	05-16-1989
KS	Miami	Sweetwater Creek Prairie	Private	0	D	1	06-02-1993
KS	Neosho	Flat Rock Prairie	Private	0	B	100	06-09-1986
MO	Adair	Williams Prairie	Private	1	D	2	05-21-2001

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
MO	Barton	Buffalo Wallow Prairie Conservation Area	Missouri Department of Conservation	8	D	2	07-06-1982
MO	Barton	Cook Memorial Meadow	The Nature Conservancy	8	C	20	06-05-1991
MO	Barton	Haines Grove School Prairie	Private	0	D	3	08-09-1993
MO	Barton	Lone Star Prairie	Private	0	C	5	07-08-1983
MO	Barton	Regal Prairie Natural Area	Missouri Department of Natural Resources	8	C	3	06-04-1999
MO	Barton	Tzi-Sho Prairie	Missouri Department of Natural Resources	8	C	6	05-28-1985
MO	Benton	Cole Prairie	Private	0	D	2	07-16-1989
MO	Benton	Cole Camp vicinity North	Private	0	D	4	06-19-1989
MO	Benton	Duran Branch Prairie	Private	0	C	23	06-06-1989
MO	Benton	Hi Lonesome Prairie Conservation Area	Missouri Department of Conservation	8	C	12	06-20-1989
MO	Benton	Hobein Prairie	Private	0	C	18	06-28-1988
MO	Benton	Lincoln Prairie	Private	0	D	4	05-30-1985
MO	Benton	Mora Prairie	Missouri Department of Conservation	8	C	6	06-22-1989

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
MO	Benton	Mora vicinity Northeast	Private	0	D	6	06-16-1989
MO	Benton	Mount Pleasant Prairie	Private	0	D	81	06-07-1989
MO	Benton	Poplar Prairie	Private	0	D	3	06-05-1984
MO	Benton	Rock Hill Prairie	The Nature Conservancy	8	C	7	1989
MO	Benton	Root Ranch	Private	0	C	13	06-20-1989
MO	Benton	Windmill Prairie	Private	0	C	10	06-28-1988
MO	Cass	South Fork Prairie	Private	2	C	16	06-02-2001
MO	Cass	West Dolan Prairie	Private	1	D	6	05-26-1988
MO	Cedar	Mo-Ko Prairie	The Nature Conservancy/Private	8	D	1	06-06-1989
MO	Cedar	Thorsen Prairie	Private	0	C	14	06-06-1989
MO	Dade	Niawathe Prairie	The Nature Conservancy/Missouri Department of Conservation	8	A	20	06-12-1993
MO	Harrison	Helton Prairie Natural Area	Missouri Department of Conservation	8	D	2	06-17-1994
MO	Harrison	Old Catholic Church	Private	2	C	3	06-09-2001

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
MO	Henry	Grand River Bottoms	Missouri Department of Conservation	8	C	12	06-06-1990
MO	Iron	Bell Mountain - West	U.S. Forest Service	6	C	24	05-24-2001
MO	Iron	St. Francois Mountains Natural Area	Missouri Department of Natural Resources	8	C	6	05
MO	Iron	Taum Sauk Mountain State Park #1	Missouri Department of Natural Resources	8	B	41	06-24-1991
MO	Iron	Taum Sauk Mountain State Park #2	Missouri Department of Natural Resources	8	C	9	05-28-1998
MO	Iron	Taum Sauk Mtn State Park - Mina Sauk Falls	Missouri Department of Natural Resources	8	C	11	05-28-2001
MO	Pettis	Bahner Branch Prairie	Private	0	D	3	07-16-1989
MO	Pettis	Bahner vicinity	Private	0	D	2	07-11-1989
MO	Pettis	Cordes Prairie	Private	0	C	16	06-14-1988
MO	Pettis	Friendly Prairie	MPF	8	D	7	05-31-1989
MO	Pettis	Grandfather Prairie Conservation Area	The Nature Conservancy	8	D	12	06-01-1989
MO	Pettis	Highway W Prairie	Private	0	D	1	06-26-1989
MO	Pettis	Paint Brush Prairie Natural Area	Missouri Department of Conservation	8	C	86	2002-06-06

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
MO	Pettis	Paint Brush Prairie Vicinity South	Private	0	C	22	06-14-1989
MO	Pettis	Shirley's Prairie	Private	0	D	1	06-27-1989
MO	Pettis	St. Paul Prairie	Private	0	D	5	07-11-1989
MO	Pettis	Vandyke Prairie	Private	0	D	1	05-22-1985
MO	Pettis	Walnut Creek Prairie	Private	0	C	25	07-28-1989
MO	Pettis	Windsor Junction vicinity East	Private	0	C	25	06-09-1989
MO	Polk	Bushy Creek Upland Prairie	Private	0	D	1	05-26-1989
MO	Polk	South Fork Upland Prairie	Private	0	D	1	05-18-1989
MO	Reynolds	Church Mountain	Missouri Department of Natural Resources	8	D	2	06-06-2001
MO	Reynolds	Ketcherside Mountain Conservation Area	Missouri Department of Conservation	8	A	89	06-18-1997
MO	St. Clair	Taberville Prairie	Missouri Department of Conservation	8	D	5	06-08-1994
MO	St. Clair	Wah-Kon-Tah Prairie	Missouri Department of Conservation	8	C	8	05-1981
MO	Vernon	Bronaugh	Private	0	C	7	06-19-1982
MO	Vernon	Gay Feather Prairie	Missouri Department of Conservation	8	C	28	07-1983

State	County	Site Name	Ownership	Protection Status [1]	EOR[2]	Number of Ramets	Date of Last Observation
MO	Vernon	KCSI Prairie	MPF	8	C	18	06-04-1994
MO	Vernon	Little Osage Prairie	The Nature Conservancy	8	C	11	1978
MO	Vernon	McGennis Prairie	Private	0	D	3	06-27-1989
MO	Vernon	Osage Prairie Natural Area	Missouri Department of Conservation	8	C	12	05-20-1981
MO	Vernon	West Twin Lakes Prairie	Private	0	C	25	06-02-1993

1 Status: 0 = No protection
1 = Landowner/manager interviewed and notified of occurrence
2 = Registration; voluntary agreement
3 = Right-of-first refusal; potential bequest; public land protection (revokable) designated in area management plan;
4 = Management agreement; lease; license
5 = Remainder interest with no management (i.e., unrestricted life estate); undivided interest
6 = Public land designation; Federal protection of federally listed species on public land; undivided interest, remainder interest in will, and management control over life estate
7 = Less than fee acquisition; conservation easement; retained rights; reverter interest; remainder interest and restricted life estate
8 = Fee title held by conservation entity; for purpose of protecting Mead's milkweed
9 = Dedication; trust investiture
? = Unknown

2 Explanation of Element Occurrence Ranking can be found in Appendix 3

APPENDIX 3.
ELEMENT GLOBAL RANKING SPECIFICATIONS FOR MEAD'S MILKWEED

A Rank
Habitat: High-quality habitats (mesic and dry-mesic tallgrass prairie, sandstone bluff, dry and dry-mesic chert prairie or dry and dry-mesic sandstone prairie) as exemplified by high native species richness and diversity, nearly complete absence (<1% cover) of non-native tree species, low cover of native grasses and prairie forbs that increase under domestic grazing pressure, large numbers of insect pollinators, and on-going natural soil disturbance (badgers, ants, pocket gophers). Habitats of this rank are managed by frequent fire and light grazing or annual mowing.

Population size and vigor: A population of 200 or more ramets (averaged over a period of 5 years), exhibiting sufficient recruitment to sustain numbers at current levels. Populations of this rank produce and release viable seeds at least once every 5 years.

B Rank
Habitat: Habitats (mesic and dry-mesic tallgrass prairie, sandstone bluff, dry and dry-mesic chert prairie or dry and dry-mesic sandstone prairie) with high native-species richness and diversity, low levels (<10% cover) of non-native or tree species, moderate levels of grass and forb species expected to increase with grazing, and low to moderate levels of small mammal disturbance and conservative prairie fauna.

Population size and vigor: A population of 100-199 ramets (averaged over a period of 5 years) exhibiting sufficient recruitment to sustain numbers at current levels. Populations of this rank produce and release viable seeds at least once every 5 years.

C Rank
Habitat: Marginal habitat (mesic and dry-mesic tallgrass prairie, sandstone bluff, dry and dry-mesic chert prairie or dry and dry-mesic sandstone prairie) as indicated by moderate levels of native species richness and diversity, moderate levels (10-30% cover) of non-native and conservative prairie fauna that contribute to the absence of a functioning ecosystem (large grazers, burrowing animals, numerous insect species).

Population size and vigor: A population of 25-99 ramets (averaged over a period of 5 years) exhibiting sufficient recruitment to sustain numbers at current levels; OR, a population greater than 99 ramets that does not produce and release viable seeds over a period of 5 years.

D Rank
Habitat: Poor quality habitat (mesic and dry-mesic tallgrass prairie, sandstone bluff, dry and dry-mesic chert prairie or dry and dry-mesic sandstone prairie) as indicated by the highly disturbed and altered nature of the occurrence. Non-native and pioneer species dominate.

Population size and vigor: A population of less than 25 ramets (averaged over a period of 5 years); OR, a population of less than 100 ramets (averaged over a period of 5 years) that does not produce and release viable seeds over a period of 5 years.

Appendix 4.

SUBSTRATE CLASSIFICATION OF MEAD'S MILKWEED POPULATIONS

State	County	Site Name	Physiographic Region	Substrate
IA	Adair	Woodside Prairie	Kansan Glaciation	Wisconsinan loess/Kansas till
IA	Clarke	Flaherty Prairie	Kansan Glaciation	Wisconsinan loess/Kansas till
IA	Decatur	Garden Grove Prairie	Kansan Glaciation	Wisconsinan loess/Kansas till
IA	Ringold	Tingley Prairie	Kansan Glaciation	Wisconsinan loess/Kansas till
IA	Taylor	Powell Prairie	Kansan Glaciation	Wisconsinan loess/Kansas till
IA	Warren	Great Western Trail, Churchville	Kansan Glaciation	Wisconsinan loess/Kansas till
IA	Warren	Great Western Trail, Cumming	Kansan Glaciation	Wisconsinan loess/Kansas till
IL	Saline	Saline #1	Unglaciated - Shawnee Hills	Pennsylvanian Sandstone
IL	Saline	Saline #2	Unglaciated - Shawnee Hills	Pennsylvanian Sandstone
IL	Saline	Saline #3	Unglaciated - Shawnee Hills	Pennsylvanian Sandstone
IL	Saline	Saline #4	Unglaciated - Shawnee Hills	Pennsylvanian Sandstone
KS	Allen	Allen #1	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Allen	Allen #2	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Allen	Paint Brush Prairie	Unglaciated - Osage Plains	Unknown
KS	Allen	Wolfpen Creek Prairie	Unglaciated - Osage Plains	Unknown

State	County	Site Name	Physiographic Region	Substrate
KS	Anderson	Anderson #1	Unglaciated - Shawnee Hills	Shawnee Group
KS	Anderson	Anderson #2	Unglaciated - Shawnee Hills	Shawnee Group
KS	Anderson	Anderson #3	Unglaciated - Shawnee Hills	Shawnee Group
KS	Anderson	Anderson #4	Unglaciated - Shawnee Hills	Shawnee Group
KS	Anderson	Anderson #5	Unglaciated - Osage Plains	Shawnee Group
KS	Anderson	Deer Creek Prairie	Unglaciated - Osage Plains	Lansing
KS	Anderson	Dumped-On Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Anderson	Garnet Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Anderson	Lone Elm Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Anderson	Lone Elm Prairie Southwest	Unglaciated - Osage Plains	Lansing
KS	Anderson	Mont Ida Cemetery Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Anderson	Mount Zion Cemetery North	Unglaciated - Osage Plains	Pd
KS	Anderson	Mount Zion Cemetery South	Unglaciated - Osage Plains	Pd
KS	Anderson	North Rich Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Anderson	Northeast Garnett Prairie	Unglaciated - Osage Plains	Lansing Group
KS	Anderson	Pipeline Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Anderson	Pott Creek Prairie	Unglaciated - Osage Plains	Unknown

State	County	Site Name	Physiographic Region	Substrate
KS	Anderson/Linn	Puppy Dog Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
KS	Anderson	Selma Prairie	Unglaciated - Osage Plains	Unknown
KS	Anderson	Southfork Pott Creek Prairie	Unglaciated - Osage Plains	Lansing Group
KS	Anderson	Sunset Prairie	Unglaciated - Osage Plains	Unknown
KS	Anderson	Two Rocks Prairie	Unglaciated - Osage Plains	Unknown
KS	Anderson	Welda Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Anderson	Welda Prairie North	Unglaciated - Osage Plains	Pd , Lansing Group
KS	Anderson	Westphalia Prairie	Unglaciated - Osage Plains	Lansing Group
KS	Bourbon	Bourbon #1	Unglaciated - Osage Plains	Pd
KS	Bourbon	Bronson Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Bourbon	Hinton Creek	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
KS	Bourbon	Little Pawnee Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)

State	County	Site Name	Physiographic Region	Substrate
KS	Bourbon	Ronald Prairie North	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
KS	Bourbon	Ronald Prairie South	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
KS	Bourbon	Treaty Line Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Bourbon	Uniontown Prairie	Unglaciated - Osage Plains	Pd
KS	Coffey	Crooked Creek Prairie	Unglaciated - Osage Plains	Pd
KS	Crawford	Farlington Prairie	Unglaciated - Osage Plains	Unknown
KS	Douglas	Baldwin Creek Prairie	Unglaciated - Osage Plains	Unknown
KS	Douglas	Blue Healer Prairie	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)
KS	Douglas	Colyer Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Douglas	Corner Prairie	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)
KS	Douglas	Dry Creek Prairie	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)
KS	Douglas	Gammagrass Prairie	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)

State	County	Site Name	Physiographic Region	Substrate
KS	Douglas	Jack's Prairie	Unglaciated - Osage Plains	Lansing Group
KS	Douglas	Jack's Prairie South	Unglaciated - Osage Plains	Pd
KS	Douglas	Kanwaka Prairie South	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)
KS	Douglas	Kanwaka Prairie West	Unglaciated - Osage Plains	Shawnee Group
KS	Douglas	Leary Prairie	Unglaciated - Osage Plains	Unknown
KS	Douglas	Lecompton Prairie	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)
KS	Douglas	Pioneer Cemetery Site	Unglaciated - Osage Plains	Pd
KS	Douglas	Rock Creek Prairie	Unglaciated - Osage Plains	
KS	Douglas	Small Lakes Prairie	Unglaciated - Osage Plains	
KS	Douglas	Spring Creek Prairie West	Unglaciated - Osage Plains	Pd
KS	Douglas	Triangle Prairie	Unglaciated - Osage Plains	Lansing Group
KS	Douglas	Turnpike Prairie	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)
KS	Douglas	Turnpike Prairie East	Unglaciated - Osage Plains	Shawnee Group
KS	Douglas	Violet Hill	Unglaciated - Osage Plains	Pd
KS	Franklin	Appanoose Prairie	Unglaciated - Osage Plains	Lansing Group

State	County	Site Name	Physiographic Region	Substrate
KS	Franklin	Bend-in-the-Road Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
KS	Franklin	Dead End Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Franklin	Double Cross Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Franklin	Elm Grove Prairie	Unglaciated - Osage Plains	Unknown
KS	Franklin	Homewood Prairie	Unglaciated - Osage Plains	Unknown
KS	Franklin	Franklin 59 Prairie	Unglaciated - Osage Plains	Unknown
KS	Franklin	Fowler Hill Prairie	Unglaciated - Osage Plains	Pd
KS	Franklin	Middle Creek Prairie	Unglaciated - Osage Plains	Pd
KS	Franklin	Mount Hope Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Franklin	Ohio Prairie	Unglaciated - Osage Plains	Lansing Group
KS	Franklin	Pottawatomie Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
KS	Franklin	Silo Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Jefferson	French Creek Prairie	Glaciated Region (Kansan)	Lansing Group

State	County	Site Name	Physiographic Region	Substrate
KS	Jefferson	Kansas University Ecological Reserve-Rockefeller Native Prairie	Glaciated Region (Kansan)	Lansing Group
KS	Jefferson	Wild Horse Prairie	Unglaciated - Osage Plains	Drift (Quaternary; Kansan and older deposits)
KS	Johnson	Camp Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Johnson	De Soto Prairie	Unglaciated - Osage Plains	Shawnee Group
KS	Johnson	Kill Creek Prairie	Unglaciated - Osage Plains	Lansing Group
KS	Johnson	Prairie Center Site	Unglaciated - Osage Plains	Lansing Group
KS	Leavenworth	Alexandria Northwest Prairie	Glaciated Region (Kansan)	Unknown
KS	Leavenworth	High Prairie	Glaciated Region (Kansan) - Glacial drift is eroded	Pd
KS	Leavenworth	Hilltop Prairie	Glaciated Region (Kansan) - Glacial drift is eroded	Pd
KS	Leavenworth	Lonesome Elm Prairie	Glaciated Region (Kansan) - Glacial drift is eroded	Missourian Series (limestone, shale, sandstone)
KS	Leavenworth	Reno Northwest Prairie	Glaciated Region (Kansan) - Glacial drift is eroded	Unknown
KS	Leavenworth	Turnpike Hilltop Prairie	Glaciated Region (Kansan) - Glacial drift is eroded	Unknown
KS	Linn	Blue Mound City Lake	Unglaciated - Osage Plains	Unknown

State	County	Site Name	Physiographic Region	Substrate
KS	Linn	Eureka Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
KS	Linn	Linn #1	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Linn	Little Pond Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Linn	Pleasant Prairie	Unglaciated - Osage Plains	Unknown
KS	Linn	Prescott Prairie	Unglaciated - Osage Plains	Unknown
KS	Linn	Sugar Creek Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Miami	Bell Branch Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Miami	Centennial Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Miami	Highland Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Miami	Metcalf Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Miami	Plum Creek Meadow	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)

State	County	Site Name	Physiographic Region	Substrate
KS	Miami	Side Hill Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Miami	Sweetwater Creek Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
KS	Miami	Springview Prairie	Unglaciated - Osage Plains	
KS	Neosho	Flat Rock Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Adair	Williams Prairie	Glaciated Plains (Kansan)	Unknown
MO	Barton	Cook Memorial Meadow	Unglaciated - Springfield Plateau (Precambrian)	Kinderhookian Series (shale, siltstone, limestone)
MO	Barton	Lone Star Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
MO	Barton	Buffalo Wallow Prairie Conservation Area	Unglaciated - Osage Plains	Unknown
MO	Barton	Haines Grove School Prairie	Unglaciated - Osage Plains	Unknown
MO	Barton	Regal Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
MO	Barton	Tzi-Sho Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)

State	County	Site Name	Physiographic Region	Substrate
MO	Benton	Cole Prairie	Unglaciated - Springfield Plateau (Precambrian)	Canadian Series (dolomite and argillaceous dolomite)
MO	Benton	Cole Camp vicinity North	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Benton	Duran Branch Prairie	Unglaciated - Osage Plains	Unknown
MO	Benton	Hi Lonesome Prairie Conservation Area	Unglaciated - Springfield Plateau (Precambrian)	Canadian Series (dolomite and argillaceous dolomite)
MO	Benton	Hobein Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Benton	Lincoln Prairie	Unglaciated - Springfield Plateau (Precambrian)	Canadian Series (dolomite and argillaceous dolomite)
MO	Benton	Mora Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Benton	Mora vicinity Northeast	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Benton	Mount Pleasant Prairie	Unglaciated - Springfield Plateau (Precambrian)	Kinderhookian Series (shale, siltstone, limestone)

State	County	Site Name	Physiographic Region	Substrate
MO	Benton	Poplar Prairie	Unglaciated - Springfield Plateau (Precambrian)	Canadian Series (dolomite and argillaceous dolomite)
MO	Benton	Rock Hill Prairie	Unglaciated - Osage Plains	Unknown
MO	Benton	Root Ranch	Unglaciated - Osage Plains	Unknown
MO	Benton	Windmill Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Cass	South Fork Prairie	Unglaciated - Osage Plains	Pd
MO	Cass	West Dolan Prairie	Unglaciated - Osage Plains	Pd
MO	Cedar	Mo-Ko Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Cedar	Thorsen Prairie	Unglaciated - Springfield Plateau (Precambrian)	Marameecian Series (limestone, dolomite, some chert and shale)
MO	Dade	Niawathe Prairie	Unglaciated - Springfield Plateau (Precambrian)	Marameecian Series (limestone, dolomite, some chert and shale)
MO	Harrison	Helton Prairie	Glaciated Plains (Kansan)	Unknown
MO	Harrison	Old Catholic Church	Glaciated Plains (Kansan)	Unknown

State	County	Site Name	Physiographic Region	Substrate
MO	Henry	Grand River Bottoms	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Iron	Bell Mountain - West	Unglaciated - St. Francois Mountains (Precambrian)	Unknown
MO	Iron	St. Francois Mountains Natural Area	Unglaciated - St. Francois Mountains (Precambrian)	Unknown
MO	Iron	Taum Sauk Mountain State Park #1	Unglaciated - St. Francois Mountains (Precambrian)	Unknown
MO	Iron	Taum Sauk Mountain State Park #2	Unglaciated - St. Francois Mountains (Precambrian)	Unknown
MO	Iron	Taum Sauk Mtn State Park -Mina Sauk Falls	Unglaciated - St. Francois Mountains (Precambrian)	Unknown
MO	Pettis	Bahner Branch Prairie	Unglaciated - Ozark Border	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	Bahner vicinity	Unglaciated - Ozark Border	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)

State	County	Site Name	Physiographic Region	Substrate
MO	Pettis	Cordes Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	Friendly Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	Grandfather Prairie Conservation Area	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	Highway W Prairie	Unglaciated - Osage Plains	Unknown
MO	Pettis	Paint Brush Prairie Natural Area	Unglaciated - Osage Plains	
MO	Pettis	Paint Brush Prairie Vicinity South	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	Shirley's Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	St. Paul Prairie	Unglaciated - Ozark Border	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)

State	County	Site Name	Physiographic Region	Substrate
MO	Pettis	Vandyke Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	Walnut Creek Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Pettis	Windsor Junction vicinity East	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Polk	Bushy Creek Upland Prairie	Unglaciated - Springfield Plateau (Precambrian)	Canadian Series (dolomite and argillaceous dolomite)
MO	Polk	South Fork Upland Prairie	Unglaciated - Springfield Plateau (Precambrian)	Canadian Series (dolomite and argillaceous dolomite)
MO	Reynolds	Church Mountain	Unglaciated - St. Francois Mountains (Precambrian)	Unknown
MO	Reynolds	Ketcherside Mountain Conservation Area	Unglaciated - St. Francois Mountains (Precambrian)	Unknown
MO	St. Clair	Taberville Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)

State	County	Site Name	Physiographic Region	Substrate
MO	St. Clair	Wah-Kon-Tah Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Vernon	Bronaugh	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Vernon	Gay Feather Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Vernon	KCSI Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Vernon	Little Osage Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)
MO	Vernon	McGennis Prairie	Unglaciated - Osage Plains	Missourian Series (limestone, shale, sandstone)
MO	Vernon	Osage Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)

State	County	Site Name	Physiographic Region	Substrate
MO	Vernon	West Twin Lakes Prairie	Unglaciated - Osage Plains	Desmoinesian Series, Krebs subgroup (sandstone, siltstone, shale, clay. limestone, coal)

APPENDIX 5.
NATURAL COMMUNITY TYPES AND LAND USE FOR EXTANT POPULATIONS OF MEAD'S MILKWEED

State	County	Site Name	Natural Community Type	Current Land Use
IA	Adair	Woodside Prairie	Mesic prairie, southern	hay meadow
IA	Clarke	Flaherty Prairie	Mesic prairie	pasture
IA	Decatur	Garden Grove Prairie	Mesic prairie, southern	abandoned RR ROW
IA	Ringold	Tingley Prairie	Mesic prairie, southern	pasture
IA	Taylor	Powell Prairie	Unknown	unknown
IA	Warren	Great Western Trail, Churchville Prairie	Mesic prairie, southern	abandoned RR ROW
IA	Warren	Great Western Trail, Cumming	Mesic prairie, southern	abandoned RR ROW
IL	Saline	Saline #1	Sandstone barrens	national forest
IL	Saline	Saline #2	Sandstone barrens	national forest
IL	Saline	Saline #3	Sandstone barrens	national forest
IL	Saline	Saline #4	Sandstone barrens	national forest
KS	Allen	Allen #1	Southeast tallgrass prairie	hay meadow
KS	Allen	Allen #2	Southeast tallgrass prairie	hay meadow
KS	Allen	Paint Brush Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Allen	Wolfpen Creek Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow/oil field
KS	Anderson	Anderson #1	Southeast tallgrass prairie	hay meadow

State	County	Site Name	Natural Community Type	Current Land Use
KS	Anderson	Anderson #2	Southeast tallgrass prairie	hay meadow
KS	Anderson	Anderson #3	Southeast tallgrass prairie	hay meadow
KS	Anderson	Anderson #4	Southeast tallgrass prairie	hay meadow
KS	Anderson	Anderson #5	Southeast tallgrass prairie	hay meadow
KS	Anderson	Deer Creek Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Dumped-On Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Garnet Prairie	Southeast tallgrass prairie dry-mesic to mesic	hay meadow/ oil field
KS	Anderson	Lone Elm Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Lone Elm Prairie Southwest	Southeast tallgrass prairie	hay meadow
KS	Anderson	Mont Ida Cemetery Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Mount Zion Cemetery North	Southeast tallgrass prairie	hay meadow
KS	Anderson	Mount Zion Cemetery South	Southeast tallgrass prairie	hay meadow
KS	Anderson	North Rich Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Northeast Garnett Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Pipeline Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Pott Creek Prairie	Southeast tallgrass prairie	SE tallgrass prairie
KS	Anderson/Linn	Puppy Dog Prairie	Southeast tallgrass prairie	hay meadow
KS	Anderson	Selma Prairie	Southeast tallgrass prairie; mesic	hay meadow/pasture

State	County	Site Name	Natural Community Type	Current Land Use
KS	Anderson	Southfork Pott Creek Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Anderson	Sunset Prairie	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow
KS	Anderson	Two Rocks Prairie	Southeast tallgrass prairie; dry mesic to wet mesic	hay meadow
KS	Anderson	Welda Prairie	Southeast tallgrass prairie; dry-mesic to wet-mesic	hay meadow
KS	Anderson	Welda Prairie North	Southeast tallgrass prairie;dry-mesic to wet-mesic	hay meadow
KS	Anderson	Westphalia Prairie	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow
KS	Bourbon	Bourbon #1	Southeast tallgrass prairie	hay meadow
KS	Bourbon	Bronson Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Bourbon	Hinton Creek	Southeast tallgrass prairie; mesic to wet-mesic	pasture
KS	Bourbon	Little Pawnee Prairie	Southeast tallgrass prairie	hay meadow
KS	Bourbon	Ronald Prairie North	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow
KS	Bourbon	Ronald Prairie South	Southeast tallgrass prairie; dry-mesic to wet-mesic	hay meadow

State	County	Site Name	Natural Community Type	Current Land Use
KS	Bourbon	Treaty Line Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow/pasture
KS	Bourbon	Uniontown Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Coffey	Crooked Creek Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Crawford	Farlington Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Douglas	Baldwin Creek Prairie	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow/pasture
KS	Douglas	Blue Healer Prairie	Southeast tallgrass prairie; dry-mesic	hay meadow
KS	Douglas	Colyer Prairie	Southeast tallgrass prairie	hay meadow
KS	Douglas	Corner Prairie	Northeast tallgrass prairie; dry-mesic to wet-mesic	hay meadow
KS	Douglas	Dry Creek Prairie	Northeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Douglas	Gammagrass Prairie	Southeast tallgrass prairie; dry-mesic to wet-mesic	hay meadow
KS	Douglas	Jack’s Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Douglas	Jack’s Prairie South	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Douglas	Kanwaka Prairie South	Southeast tallgrass prairie; mesic	hay meadow

State	County	Site Name	Natural Community Type	Current Land Use
KS	Douglas	Kanwaka Prairie West	Southeast tallgrass prairie; mesic	hay meadow
KS	Douglas	Leary Prairie	Northeast tallgrass prairie; mesic	hay meadow
KS	Douglas	Lecompton Prairie	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow
KS	Douglas	Pioneer Cemetery Site	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow/ natural area
KS	Douglas	Rock Creek Prairie	Northeast tallgrass prairie; mesic to wet-mesic	hay meadow
KS	Douglas	Small Lakes Prairie	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow
KS	Douglas	Spring Creek Prairie West	Southeast tallgrass prairie	hay meadow
KS	Douglas	Triangle Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Douglas	Turnpike Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Douglas	Turnpike Prairie East	Northeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Douglas	Violet Hill	Southeast tallgrass prairie	hay meadow
KS	Franklin	Appanoose Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Franklin	Bend-in-the-Road Prairie	Southeast tallgrass prairie	hay meadow/oilfield
KS	Franklin	Dead End Prairie	Southeast tallgrass prairie	hay meadow
KS	Franklin	Double Cross Prairie	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow

State	County	Site Name	Natural Community Type	Current Land Use
KS	Franklin	Elm Grove Prairie	Southeast tallgrass prairie	hay meadow
KS	Franklin	Fowler Hill Prairie	Southeast tallgrass prairie; mesic to wet-mesic	hay meadow
KS	Franklin	Franklin 59 Prairie	Southeast tallgrass prairie	unknown
KS	Franklin	Homewood Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Franklin	Middle Creek Prairie	Southeast tallgrass prairie	hay meadow
KS	Franklin	Mount Hope Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Franklin	Ohio Prairie	Southeast tallgrass prairie; mesic prairie	hay meadow
KS	Franklin	Pottawatomie Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Franklin	Silo Prairie	Southeast tallgrass prairie	hay meadow
KS	Jefferson	French Creek Prairie	Southeast tallgrass prairie	hay meadow
KS	Jefferson	Kansas University Ecological Reserve-Rockefeller Native Prairie	Northeast tallgrass prairie; mesic	burned 2-3 years
KS	Jefferson	Wild Horse Prairie	Northeast tallgrass prairie	hay meadow
KS	Johnson	Camp Prairie	Southeast tallgrass prairie	hay meadow
KS	Johnson	De Soto Prairie	Southeast tallgrass prairie; mesic	hay meadow

State	County	Site Name	Natural Community Type	Current Land Use
KS	Johnson	Kill Creek Prairie	Northeast tallgrass prairie	natural area
KS	Johnson	Prairie Center Site	Southeast tallgrass prairie; mesic	natural area
KS	Leavenworth	Alexandria Northwest Prairie	Unknown	unknown
KS	Leavenworth	High Prairie	Northeast tallgrass prairie; dry-mesic to wet-mesic	hay meadow
KS	Leavenworth	Hilltop Prairie	Northeast tallgrass prairie;	hay meadow
KS	Leavenworth	Lonesome Elm Prairie	Northeast tallgrass prairie; dry-mesic	hay meadow
KS	Leavenworth	Reno Northwest Prairie	Unknown	hay meadow
KS	Leavenworth	Turnpike Hilltop Prairie	Unknown	hay meadow
KS	Linn	Blue Mound City Lake	Unknown	hay meadow
KS	Linn	Eureka Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Linn	Linn #1	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Linn	Little Pond Prairie	Southeast tallgrass prairie	hay meadow
KS	Linn	Pleasant Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Linn	Prescott Prairie	Unknown	unknown
KS	Linn	Sugar Creek Prairie	Southeast tallgrass prairie; dry-mesic to wet-mesic	hay meadow

State	County	Site Name	Natural Community Type	Current Land Use
KS	Miami	Bell Branch Prairie	Southeast tallgrass prairie	hay meadow
KS	Miami	Centennial Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Miami	Highland Prairie	Southeast tallgrass prairie; mesic	hay meadow
KS	Miami	Metcalf Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Miami	Plum Creek Meadow	Southeast tallgrass prairie	hay meadow
KS	Miami	Side Hill Prairie	Southeast tallgrass prairie	hay meadow
KS	Miami	Sweetwater Creek Prairie	Southeast tallgrass prairie	hay meadow
KS	Miami	Springview Prairie	Southeast tallgrass prairie; dry-mesic to mesic	hay meadow
KS	Neosho	Flat Rock Prairie	Southeast tallgrass prairie	hay meadow
MO	Adair	Williams Prairie	Unknown	unknown
MO	Barton	Buffalo Wallow Prairie Conservation Area	Dry-mesic shale prairie	hay-/rest/burn rotation
MO	Barton	Cook Memorial Meadow	Dry-mesic chert prairie	hay/burn rotation
MO	Barton	Haines Grove School Prairie	Dry-mesic sandstone/shale/ hardpan	hay meadow
MO	Barton	Lone Star Prairie	Dry-mesic sandstone prairie	hay meadow
MO	Barton	Regal Prairie	Dry-mesic sandstone prairie	graze/burn rotation
MO	Barton	Tzi-Sho Prairie	Dry-mesic sandstone prairie	hay/rest/burn rotation

State	County	Site Name	Natural Community Type	Current Land Use
MO	Benton	Cole Prairie	Dry-mesic chert prairie	hay meadow/pasture
MO	Benton	Cole Camp vicinity North	Unknown	unknown
MO	Benton	Duran Branch Prairie	Dry mesic prairie	unknown
MO	Benton	Hi Lonesome Prairie Conservation Area	Dry-mesic chert prairie	hay meadow/pasture
MO	Benton	Hobein Prairie	Dry-mesic chert prairie	hay meadow
MO	Benton	Lincoln Prairie	Unknown	hay meadow
MO	Benton	Mora Prairie	Dry-mesic chert prairie	hay meadow
MO	Benton	Mora vicinity Northeast	Dry-mesic chert prairie	hay meadow
MO	Benton	Mount Pleasant Prairie	Dry-mesic chert Prairie	hay/winter pasture
MO	Benton	Poplar Prairie	Dry-mesic chert prairie	pasture burn rotation
MO	Benton	Rock Hill Prairie	Dry-mesic chert prairie	hay/pasture/burn
MO	Benton	Root Ranch	Dry-mesic chert prairie	hay meadow
MO	Benton	Windmill Prairie	Dry-mesic chert	unknown
MO	Cass	South Fork Prairie	Dry-mesic limestone prairie	idle
MO	Cass	West Dolan Prairie	Mesic prairie	hay meadow
MO	Cedar	Mo-Ko Prairie	Dry-mesic sandstone prairie	hay/burn rotation
MO	Cedar	Thorsen Prairie	Dry-mesic chert prairie	unknown
MO	Dade	Niawathe Prairie	Dry-mesic sandstone prairie	hay/burn rotation

State	County	Site Name	Natural Community Type	Current Land Use
MO	Harrison	Helton Prairie	Mesic Prairie	hay/burn/rest rotation
MO	Harrison	Old Catholic Church	Mesic Prairie	Prescribed burned
MO	Henry	Grand River Bottoms	Unknown	unknown
MO	Iron	Bell Mountain - West	Igneous glade	natural area
MO	Iron	St. Francois Mountains Natural Area	Igneous glade	natural area
MO	Iron	Taum Sauk Mountain State Park #1	Igneous glade	natural area
MO	Iron	Taum Sauk Mountain SP #2	Igneous glade	natural area
MO	Iron	Taum Sauk Mtn State Park -Mina Sauk Falls	Igneous glade	natural area
MO	Pettis	Bahner Branch Prairie	Dry-mesic chert prairie	hay meadow
MO	Pettis	Bahner vicinity	Dry-mesic chert prairie	unknown
MO	Pettis	Cordes Prairie	Dry-mesic prairie	hay meadow
MO	Pettis	Friendly Prairie	Dry-mesic chert prairie	hay/burn rotation
MO	Pettis	Grandfather Prairie Conservation Area	Dry mesic prairie	hay/burn rotation
MO	Pettis	Highway W Prairie	Dry-mesic chert prairie	unknown
MO	Pettis	Paint Brush Prairie Natural Area	Dry-mesic chert prairie	hay/burn rotation

State	County	Site Name	Natural Community Type	Current Land Use
MO	Pettis	Paint Brush Prairie Vicinity South	Dry-mesic chert prairie	hay/burn rotation
MO	Pettis	Shirley's Prairie	Dry-mesic chert prairie	unknown
MO	Pettis	St. Paul Prairie	Dry-mesic chert prairie	hay meadow
MO	Pettis	Vandyke Prairie	Dry-mesic chert prairie	unknown
MO	Pettis	Walnut Creek Prairie	Dry-mesic chert prairie	hay meadow
MO	Pettis	Windsor Junction vicinity East	Dry-mesic chert prairie	unknown
MO	Polk	Bushy Creek Upland Prairie	Dry-mesic sandstone/shale prairie	grazed prairie
MO	Polk	South Fork Upland Prairie	Dry-mesic chert prairie	hay meadow
MO	Reynolds	Church Mountain	Igneous glade	natural area
MO	Reynolds	Ketcherside Mountain Conservation Area	Igneous glade	natural area
MO	St. Clair	Taberville Prairie	Dry-mesic sandstone prairie	natural area
MO	St. Clair	Wah-Kon-Tah Prairie	Dry-mesic chert prairie	natural area
MO	Vernon	Bronaugh	Dry-mesic sandstone prairie	hay meadow
MO	Vernon	Gay Feather Prairie	Dry-mesic sandstone prairie	natural area
MO	Vernon	KCSI Prairie	Dry-mesic sandstone/shale prairie	unknown
MO	Vernon	Little Osage Prairie	Dry-mesic sandstone prairie	natural area
MO	Vernon	McGennis Prairie	Mesic Prairie	unknown

State	County	Site Name	Natural Community Type	Current Land Use
MO	Vernon	Osage Prairie Natural Area	Dry-mesic sandstone prairie	natural area
MO	Vernon	West Twin Lakes Prairie	Dry-mesic sandstone/shale prairie	unknown

APPENDIX 6.
Common Plant Associates of Mead's Milkweed in Tallgrass Prairie Habitats

SPECIES	COMMON NAME
Achillea millefolium	yarrow
Agrostis hyemalis	tickle grass
Amorpha canescens	lead plant
Andropogon gerardii	big bluestem grass, turkeyfoot
Andropogon scoparius	little bluestem grass
Antennaria neglecta	cat's foot
Asclepias tuberosa	butterfly weed
Asclepias viridis	Ozark milkweed
Baptisia bracteata	plains wild indigo
Coreopsis palmata	prairie coreopsis
Dalea candida	white prairie-clover
Dalea purpurea	purple prairie-clover
Desmanthus illinoensis	Illinois bundleflower
Dichanthelium oligosanthes	few flowered panic grass
Echinacea pallida	purple coneflower
Erigeron strigosus	daisy fleabane
Eryngium yuccifolium	rattlesnake master
Gentiana puberulenta	prairie gentian
Liatris pycnostachya	prairie blazing star, gay feather
Lithospermum canescens	hoary puccoon
Lobelia spicata	pale spiked lobelia
Phlox pilosa	prairie phlox
Polytaenia nuttallii	prairie parsley
Psoralea tenuiflora	scurfy pea

SPECIES	COMMON NAME
Sisyrinchium campestre	prairie blue-eyed grass
Sorghastrum nutans	Indian grass
Sporabolus heterolepis	prairie dropseed
Stipa spartea	porcupine grass
Tripsacum dactyloides	gama-grass
Viola pedatifida	prairie violet